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The main headings of the four-mile tunnel for the Chicago water-works met on June 22. On June 25 First Assistant City Engineer Bernhard Feind wrote us that there still remained to be driven 3 ft. of one of the 6-ft. branches of the tunnel. In addition repairs to some defective portions must be made and the tunnel must be cleaned out. The tunnel was started about four and a half years ago as an 8-ft. tunnel, but difficulty with the material necessitated a change to two 6-ft. tunnels for a part of the distance. The tunnel as carried out until that time was described and illustrated in Engineering News of July 5, 1890.

The net earnings of 127 railways for the month of April are $15,999,078, a decrease of 0.09% from those of the corresponding month of 1891, according to the "Financial Chronicle." This somewhat unfavorable result is attributed to the bad weather, small grain and cotton shipments, depressed iron trade, and the general industrial depression in the South and on the Pacific Coast. In addition several of the larger roads show large increases in operating expenses. The Southern roads, on the whole, present less favorable exhibits than any others, showing a decrease of 10.65%. Seventeen of the 27 roads in this section exhibit decreases. The Northwestern roads show a decrease of 9.09%, and the Southwestern, a decrease of 6.26%. In the Anthracite coal group there is a general improvement, and the trunk lines show but slight changes. In the Middle States, five roads have losses and eight have gains, and in the Middle Western States, eleven roads report losses and ten gains.

An improved sewerage and drainage system for Indianapolis is proposed and has recently been reported upon by Mr. Rudolph Hering, Mem. Am. Soc. C. E. Mr. Hering recommends a combined system designed to provide for a population of 240,000. A maximum rainfall of 3 ins. per hour is assumed. This is based on the records of heavy showers in Indianapolis for the 21 years, 1871 to 1891, during which time there have been 20 showers at the rate of 1 in. per hour and over, 8 of more than 2 ins. per hour and one at the rate of 5.76 ins. per hour. The disposal of the sewage, as recommended, will be by gravity into White River.

Some interesting facts on the defilement of the ground are given in Prof. Glasenapp's report on his analytical and chemical investigations of the ground, the ground water and several open wells, being part of the preliminaries for the systematic canalization and sanitation of the city of Riga. According to the "Industriezeitung" of that city, Prof. Glasenapp stated that the ground of the inner or oldest part of the city was saturated to a depth of 14½ ft. with 105,000,000 lbs., approximately, of nitrogenous matter, mostly of animal origin. This enormous quantity equals the product of 100,000 adult persons in about 25 years. Some of the old sewers of the city show leakages and were the source of contamination of the adjacent ground, which was also the case with the board-lined cess-pools in use. In some instances organic matter could distinctly be traced at a depth of 14 to 15 ft. The ground of the cemeteries, however, showed a comparatively small amount of pollution.

The commission appointed by the Supreme Court to decide upon the necessity of the proposed routes of transit recommended by the New York Rapid Transit Commission (See Eng. News, Oct. 24, 1891, for map and report) reported on June 17 that there was public necessity for the whole of the west side route, and for that portion of the east side route between Broadway and Fourteenth St., and the Grand Central Station, at Forty-second St., omitting, however, the extension of the east side line up Madison Ave., and beyond. The Commission also express their belief that bidders will be found for the franchise if offered at auction. A motion to confirm the report will be argued before the General Term, June 29. This is not likely to be much more than a formal proceeding, and if the report is confirmed it will then become the duty of the Rapid Transit Commission to resume their labors, and prepare plans and details for putting the franchise up at auction.

News reaches us from New South Wales that charges made against the recently imported Baldwin locomotives are likely to end in a miserable fiasco, and that the conduct of the Railway Commissioners in purchasing these engines will be thoroughly indorsed, despite the howls of political malcontents. With absurdly few exceptions, all the innumerable witnesses called by the latter have testified strongly in favor of the Baldwin engine, and both in trials and daily work they are stated to be hauling more than their stipulated load. While some defective engine truck and tender axles are admitted, the witnesses agree in stating that the engines (12 passenger ten-wheelers and 20 consolidation) are doing remarkably good work up the long 176, 160 and 132 ft. grades, and are very easy on the track.

The charges are being inquired into before a Royal Commission, consisting of three gentlemen who have power to send for persons and papers and take testimony on oath. Their sittings were not concluded when the mail left Sydney.

The worst accident of the week was a tail collision between two sections of the Western express, on the Pennsylvania R. R., a few hundred feet from the Harrisburg depot, about 12:20 a. m., on the morning of June 25. A heavy private car at the rear of the first section, belonging to Geo. Westinghouse, Jr., was almost uninjured, but it crushed in the three cars ahead, killing 12 persons and seriously injuring 17, among the latter Mr. Wm. B. Parsons, Consulting Engineer, of this city, who was badly cut about the head and face and may lose one eye. Some 70 were injured in all. The collision was caused by a breakdown of the block system on that road, which is of the original simple type, each operator having full control of his own signal. The first section had been stopped outside of the station by some switching work, and the block operator gave line clear to the second section without waiting to have the first section reported off, assuming that it either had cleared or would clear. He was a raw country lad, 22 years old, who had been in the service but a few months, and who was only a substitute operator. He claimed, and possibly with truth, that he had known of other operators doing the same thing. Until human nature has been made over there will always be some who will run such risks if it is left to their unchecked discretion.

Two serious wrecks at culverts are reported this week, one on the Grand Trunk, near Hillhurst, P. Q., where a passenger train ran into a deep washout and four persons were killed, the other on the Cincinnati, Wabash & Michigan, where a culvert which had been weakened in making repairs gave way under a passenger train.

A serious rear collision occurred on the Great Eastern Ry., England, in London, June 14. A crowded workmen's train from a suburban district to the city was standing at the Bishopsgate St. station, when it was run into by a similar train, and the three rear cars crushed and telescoped. Three persons were killed and about ten were injured. Bishopsgate St. is the last station before the Liverpool St. terminal station, and is in a deep open cut with retaining walls, close to the mouth of a tunnel. The line is worked on the absolute block system, but owing to "a misunderstanding between two signalmen" and the lack of any mechanical check against such misunderstanding, the second train was given the "track clear" signal. The busy lines of English railways near the various London terminal stations are generally very efficiently protected by signals and safety appliances, but automatic appliances are not favorably considered by English engineers as a rule, and the combined Sykes system is not yet very largely used. In such cases as this, however, or the similar case at Harrisburg last week, their advantages are evident. The value and reliability of automatic signals has been conclusively shown in this country, and a signal and interlocking system combining automatic with hand operated appliances approaches perfection.

The electric elevated railway at Baltimore, Md., is likely to be built in a few months. The Lake Roland Elevated Ry. Co. has awarded the contract for the elevated structure on North St. to the Pennsylvania Steel Co., the contract including masonry, materials and construction. There will be about 3,000,000 lbs. of steel work. The elevated structure will be double track and 4,000 ft. long, and with the double track viaduct 400 ft. long over the Baltimore & Lehigh R. R., at Stony Run, the contract for which has also been given to the Pennsylvania Steel Co., there will be nearly two miles of single track. The elevated portion on North St. will be constructed so as to offer a minimum obstruction to persons using the street. As there will be no ashes to fall there will be no necessity for guards under the track, and the light from above will be but slightly obstructed. The structures will be built so that a speed of 12 to 15 miles an hour can be maintained. There will be eight elevated stations. The stations will be roofed, so that passengers will be protected from the weather. There will be sidewalk entrances similar to those at the elevated stations in New York. The central station will be at the southern end of the line. The contract for the electric equipment has been awarded to the General Electric Co., (the consolidated Edison, Thomson-Houston and Fort Wayne companies). The railway will have 21 miles of single track, and the gage will be the same as the other Baltimore street railways. The motors have arrived and the cars have been ordered from the Pullman Car Co. The cars will be 24 ft. long, and will have paper wheels. A uniform fare of 5 cts. will be charged. Mr. John Waters, the contractor, has commenced work on the power house, and the Pennsylvania Steel Co. expects to begin work shortly. Mr. Samuel M. Jarvis is President of the Lake Roland Elevated Co.

The Fruit Hill Reservoir of the Providence, R. I., water-works continues to leak, it appears, although some $90,000 have been expended for repairs to the structure. This reservoir was completed late in 1889. It has a bottom area of 3.22 acres and a capacity of 25,000,000 gallons. It was designed for high service. Soon after the reservoir was completed serious leaks developed. In 1890 Engineers J. B. Francis, B. S. Church and J. H. Shedd reported that the leaks were probably caused by the seamy character of the ledge beneath a part of the embankment and the porous nature of the puddle used for lining. A part of the inner slope was rebuilt after the report was made, material for a portion of the rebuilding being excavated from the river bed. Nov. 24, 1891, about 9 ft. of water was admitted to the reservoir to protect the bottom from the action of frost during the winter. Recently the reservoir was filled and the leakage continues, though apparently not so badly as at first. Before the repairs were made, Mr. S. R. Gray, City Engineer while the reservoir was being built, stated that the leaks could be stopped by applying concrete to the seamy places in the rock, and at a cost of $8,000. The original cost of the reservoir was about $135,000.

Triple-expansion engines have been fitted to the side wheel steamer "City of Toledo," running from Toledo, O. The engines are inclined, the cylinders being dropped below the plane of the crank shaft. The cylinders are 26, 42 and 66 ins. diameter and 6 ft. stroke. The high-pressure cylinder is between the others, and has a piston valve operated by the Joy valve gear. The intermediate and low-pressure cylinders have double ported slide valves and link motion. The wheels are 19 ft. 6 ins. diameter, with nine feathering floats 9 ft. 6 ins. wide. There are two boilers 10 ft. 10 ins. diameter, 21 ft. long, each with three 46-in. furnaces and carrying 160 lbs. of steam. The engines have developed 1,641 I. HP. at 40 revs. per minute. They were designed and built by the Cleveland Shipbuilding Co., of Cleveland, O. The steamer is built of steel, and is 210 ft. long on the water line, 32 ft. beam, and 12 ft. 6 ins. deep, and is guaranteed to run 16 statute miles per hour.

Placing wires along the railway tracks underground in order to make them secure against injury by storms is reported to be under consideration by officers of the Pennsylvania R. R. The cost is undoubtedly greater than for stringing the wires on poles, and repairs are much more difficult. On the other hand, if properly installed, the circuits should need repairs very seldom and should be far more reliable.

THE TANSA DAM, BOMBAY WATER-WORKS.

The Tansa Dam, which forms the reservoir from which the new gravity water supply of the city of Bombay, India, is obtained, is said to be the longest masonry dam in the world, but is not the highest. It is about 9,000 ft. long, 118 ft. high, 100 ft. wide at the bottom of the deepest part, and 15 ft. 6 ins. wide on top. The works for the new water supply were described in our issues of May 23, 1891; April 9 and May 19, 1892, and the following particulars of the great dam are taken from an article in "Engineering," of London. Fig. 1 is a longitudinal section, and Fig. 2 a cross-section. In Fig. 2 the heavy figures at the inner and outer faces represent the pressures in pounds per square inch, with the reservoir empty and full respectively. The latter have been calculated by Bouvier's modified formula, which gives figures much in excess of those arrived at by the usual formula of Dolocre. For instance, the maximum pressure shown at 86 lbs. per sq. in. would be only 67 lbs. according to the usual formula. The shaded portion shows the middle third of the dam. In the calculations the weight of masonry was taken at 150 lbs. per cu. ft. As will be seen by the cross-section, the inside face has a slight batter at the bottom. The outside face has a flat slope at the lower part, with a curve of 160 ft. radius for the upper part. The waste weir is 1,600 ft. long, and 3 ft. below the top of the dam. The design of the dam was prepared with a view to raising it 15 ft. at some later time, if required, which will make the crest 133 ft. above the river level. The lake will then cover an area of eight sq. miles, with a catchment after allowing for evaporation, etc., will then be basin or area of 52 sq. miles. The available supply, 68,000,000 gallons per day for 365 days, or practically 100,000,000 gallons per day, as, allowing for the fall during the rainy season, the supply stored is only required to meet the demand for 240 days.

The foundations are in solid rock throughout, and care was taken to remove every part where the least doubt existed on this point, and to this end the foundations have in some cases been carried down 45 ft. below original ground level. The quantity of excavation actually carried out in soft boulders, loose rock and rock amounted to 251,127 cu. yds., or 66% above the estimated quantity of 151,272 cu. yds. for foundations. The masonry consists of uncoursed rubble, anything approaching horizontal joints being carefully avoided; and good bond was carefully seen to throughout the work. Every stone was carefully laid in mortar and driven home with a light mallet. The top course of the dam was, by the use of carefully selected, flat-topped stones, brought to a uniform level, having the appearance of rubble paving. The face stones were laid without priming in front, and were specially selected of a larger size, to insure good beds, and of uniform color. They were laid so as to tail back and bond well into the body of the work, and no face stone had a greater height than either its breadth on the face, or length of tail in the work. The face work is equal to and has the appearance of coursed rubble. The quantity of loose rubble stone used in the dam amounted to 544,700 cu. yds. The mortar consisted of one part of kunker lime to one and a half of clean, sharp sand, with the exception of the lower and thickest portion of the dam in the bed of the river, where a proportion of Portland cement was added to the above. The mortar was ground in steam mortar pans for 15 minutes before being used, and the proportions of lime and sand were carefully gaged by specially made frames. The lime was all burned and prepared by the contractors, most of it at the site of the works. The kunker nodules, out of which the lime was made, had to be excavated from some feet underground, where they were quarried, and after being exposed in the sun and thoroughly dried, were separated from all extraneous matter, such as earth, etc., by beating and washing. The kunker used in this work is well known for its special hydraulic properties, and has a high reputation. After being cleaned it had to be carted to the railway stations, an average distance of 10 miles, then by train about 70 miles, and again carted 8 miles to the mortar mill sheds at Tansa. The total quantity of lime used was 81,700 cu. yds. The sand was clean, hard and sharp from quartz and trap formations, and was carefully washed to remove dirt. It was carted from about 1½ miles in the first season, the distance increasing in each subsequent season up to 12 miles of carting. over most difficult country without made roads. The total quantity of washed sand used in the work amounted to 122,555 cu. yds. During the working season as many as 700 to 900 carts were employed in the conveyance of sand, lime, etc.

Samples of the mortar were tested regularly, being made into 4-in. cubes, and after being immersed in water for from 6 to 18 months were tested by hydraulic power. The general results averaged from 400 to 1,000 lbs. per sq. in. before crushing, and were considered very satisfactory. The face joints of the masonry were raked out to the depth of 1 in. and carefully pointed with Portland cement on the inner face and ordinary mortar on the outer side.

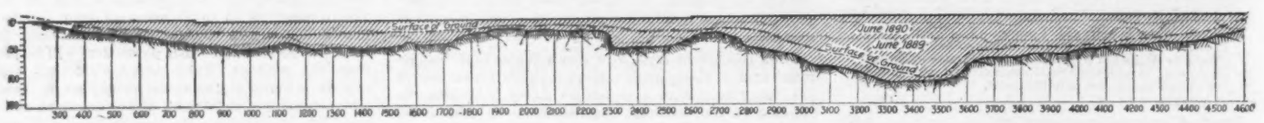


FIG. 1. PROFILE OF TANSA DAM

The proportion of mortar used in the masonry was carefully checked and found to average 30.7%. The original estimate of the quantity of masonry was 371,800 cu. yds., and the actual amount was 408,520 cu. yds. The largest amount of work done in a month was in January, 1891, when 26,000 cu. yds. were executed by 700 masons. During the working season, from October to the end of May, from 9,000 to 12,000 men were employed. During the rainy season, from May to October, work was suspended,

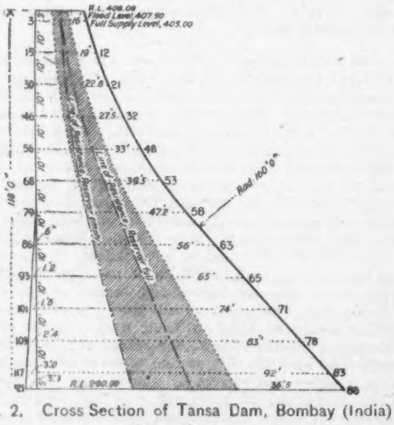


Fig. 2. Cross Section of Tansa Dam, Bombay (India) Water-Works.

with the exception of quarrying when a lull in the rains would permit. The work in connection with the dam was commenced in March, 1886, and was completed on April 3, 1891, or 15 months ahead of contract time. The lake was full of water during the last monsoons, and the dam proved perfectly watertight. The site of the dam is in a dense forest and jungle; a macadamized road had to be built from the railway, a distance of eight miles, and in order to induce native laborers to come to the works and remain a village had to be established and food supplied by a contractor at 3% under the market prices at Bombay. A regular police force was established by the contractors, and hospitals, sanitary arrangements and medical attendance provided, with the result that no serious crime occurred, and the people were free from epidemics. At the commencement of the work in 1886 no water was available, and the contractors put in a pumping plant to pump water from the river below the works to masonry filter tanks, until the dam was high enough to impound a supply sufficient for the works and village. This plant was afterward increased and used for carrying on the works, there being four steam pumps and six miles of distribution pipe.

The dam, pipe lines and aqueduct for conveying the water to Bombay, forming the whole water supply scheme, were designed by and carried out under the supervision of W. J. B. Clerke, M. Inst. C. E. The first suggestion for a dam at this site was made by Major H. Tulloch, R. E., chief engineering expert to the Local Government Board, who reported on different schemes for the water supply of Bombay several years ago. The contractors for the dam were Glover & Co., of Calcutta, and for the aqueducts, etc., were Walsh, Lovett & Co., of Calcutta. The pipe lines have required 50,000 tons of 48-in. cast iron pipe, each length weighing 4 tons. These pipes were supplied by Macfarlane, Strang & Co., of Glasgow, Scotland, and are laid above ground. The works were opened March 31, 1892, and the Municipal Commissioner of Bombay then advertised for offers for the purchase of two Worthington pumping engines built in 1889-90 by James Simpson & Co., London. The engines are horizontal triple-expansion jet-condensing, with pumps of the Worthington direct-acting duplex type. The boilers are by the Babcock & Wilcox Co. Each engine is capable of lifting 4,000,000 gallons 100 ft. high per 24 hours. The plant has given entire satisfaction and is only to be disposed of on account of the opening of the Tansa works, which have rendered an auxiliary supply by pumping unnecessary.

COMPOUND LOCOMOTIVE TESTS.

The following is the continuation and conclusion of the interesting discussion on compound locomotives at the Master Mechanics' Convention last week. We have commented on the report and discussion, and on some features of the general question not raised in either, on another page:

Mr. J. N. Lauder (Old Colony), said that while he was inclined to take a conservative view of the compound locomotive question, he believed that the outcome would be a more economical locomotive than had ever been available. He thought gains of 30 or 40% in economy were invariably due to abnormal circumstances, and ought not to be counted on at all. He believed the gain would be large enough, however, to warrant the use of compound locomotives on roads paying a high price for fuel. One year ago he was under the impression that a compound locomotive needed to be especially designed for the work it was to do. His experience during the past year had materially modified this impression. The compound locomotive on the Old Colony has been worked in suburban service, in heavy fast passenger traffic, both express and local, and on fast and heavy freight, and has shown excellent results everywhere, except in the very fastest service. The only trouble here has been due simply to too small wheels. By increasing the stroke from 24 ins. to 26 ins., and increasing the size of the wheel the engine would be suited for very fast running.

He expected a saving in fuel great enough to warrant the further use of the compound. There is certainly enough in the compound to warrant all the important railways in spending some money to develop it and in trying it on a considerable scale.

One peculiarity of the compound had surprised him, the facility with which it would get a train up to speed, a heavy suburban train for instance.

The Old Colony compound requires a somewhat smaller exhaust nozzle than a simple engine.

The draft at first was very poor, but the trouble was remedied by increasing the diameter of the smokestack at the base. The exhaust of the compound being at a lower terminal pressure, spreads more quickly; and it struck the bottom of the smoke arch before the stack was enlarged. At present the engine steams admirably. She draws the steamboat express with 10 or 12 cars up a 44 ft. grade, six to eight miles long, with the door open nearly all the way, and maintains the boiler pressure at 190 lbs. Finally he thought that more skill was necessary to design a compound locomotive than a sim-

ple one. The advantages to be gained, however, are such that railways can well afford to employ special talent to aid them in the design of compound locomotives if necessary.

Mr. Vauclain disputed the statement that repairs were certain to be much heavier on the compound locomotive than on the simple. The additional parts, the cylinders and intercepting valves will cause some increased cost for repairs; but on the other hand the boiler will not be worked so hard, the firebox sheets will last longer and tube ends will not be cut out so soon with the lighter draft. These are the items which count for most in the repairs bill, and the saving here will much more than offset the increased repairs on cylinders and valves. There are 20 Vauclain compounds on the Chicago & South Side Elevated R. R., which are doing harder work than any locomotive on the Pennsylvania R. R., between Philadelphia and New York. The fact that the compound locomotive can start more quickly is partly due to the fact that it has less steam to force through the exhaust ports. Benefit is obtained even with simple engines by increasing the size of the port openings. It has been stated that the Old Colony compound requires a smaller exhaust nozzle than the simple engine. In a few cases this has been necessary with Vauclain compounds, but against this in 15 or 20 cases the exhaust nozzle has been made larger in the compound than in the simple engine.

Mr. Lauder objected to the statement that repairs would be less on the boilers of the compound locomotive. The higher boiler pressure carried would necessitate increased repairs.

Mr. Dolbeer (Buffalo, Rochester & Pittsburg) said that as coal cost his company only $1.25 per ton, he did not believe the compound locomotive could save them much money. Nevertheless last fall he had ordered two Vauclain compounds at the request of his vice-president; two simple locomotives of the same type and dimensions were ordered at the same time. The compound carried 175 lbs. pressure, the other engines 140 lbs. The monthly record of fuel consumption was kept for them, as for all engines on the road, with the following results:

Month.	Percentage of fuel saved by compound.
November	16%
December	12%
January	32%
February	6%
March	−7%
April	15%
May (1 to 2)	12%

The great falling off in economy in the month of March he attributed to a change of engineers. He claimed, however, that the test was really not a fair one to the simple engine, since its boiler pressure was so much lower than the compound. His experience was that a simple engine would, sometimes, be found having a phenomenally low fuel consumption, and it would be discovered that some one had been tampering with the safety valve so that the pressure had run up 10 or 15 lbs. higher than the regulation point. With reference to some matters aside from fuel economy, during the period covered by the report the compound made 17,124 miles and the simple engine made 19,884 miles. The tire wear on the compound engine was about 40% greater than on the simple engine, the reason being, of course, that the compound had slipped her drivers more. In conclusion he said that in an emergency, or a very hard pull, he had found that the compound would beat the simple engine.

Mr. A. E. Mitchell, the new Superintendent of Motive Power of the New York, Lake Erie & Western, said that five Vauclain compound decapods, weighing 205,000 lbs. apiece, had been at work since Jan. 1, on the Delaware Division, hauling trains up a grade 8¼ miles long. The work is so heavy that three engines have usually been used to take a train up the hill, but these engines, which have a cylinder power designed to be equal to a simple engine with 24×28 in. cylinders, do the work which formerly required two consolidation engines. They burn culm and buckwheat coal, a cheaper grade of fuel than was used on consolidations. One fireman fires them with ease. From present appearances he did not think repairs would be very expensive. An important point is that these engines are not throwing any fire from the stack, the reduction of fire losses for which the railway is responsible will be an important point in the compound's favor.

Mr. Jas. Macbeth said he was at one time firm in the belief that the two-cylinder compound must have a great side oscillation on account of the unequal work done by the two-cylinders. Not until he had spent many days riding on Schenectady compounds, at various speeds and conditions of service, was he convinced that the engines were free from side oscillation. He now had ten two-cylinder compounds in service and all of them rode perfectly. A 5-in. exhaust nozzle is used and there is no lack of steam. The lighter exhaust of the locomotive decreases the liability of setting fires at least 30 to 40%. He had recently made a comparative test of simple and compound locomotives on the Central Vermont, which showed a saving in coal of 30 to 35%; and the compound evaporated 8¼ lbs. of water per lb. of coal against the simple engine's 5½ lbs. He had as yet seen no evidence that repairs on the compound were to be more expensive than on the simple.

Mr. F. W. Dean said the Old Colony two-cylinder compound showed considerable oscillation at first, but it was obviated by increasing the clearance of the high-pressure cylinder ¼ in., making the clearance volume about 11½%. At present the oscillation can hardly be discovered, and it could be entirely stopped by giving a little more clearance, which would give greater volume for compression. It would be desirable to have the clearance about 15%. The clearance on the low-pressure cylinder is 5¾%, but he would increase this somewhat in building another locomotive. The Old Colony simple engines, in competition with which this engine was tested, he believed to be among the very best simple engines running. Mr. Lauder has taken unusual pains in protecting the cylinder saddle on all sides from loss of heat by radiation. The compound was first tested in fast freight service at speeds of 25 to 30 miles per hour in competition with an engine, built at the same time. The saving was about 31%, notwithstanding the fact that part of the runs with the compound were made with an inferior coal. If the coal had all been of good quality he thought 36 or 38% would have been reached. These tests were made on round trips between Boston and Fall River. The simple engine blew off rather more than the compound. Recently tests have been made on express passenger work with two different trains, and in each case an economy of about 30% has been shown.

Mr. Dean said he had also designed a compound for the Lehigh Valley 20 and 30×24 ins., with 180 lbs. boiler pressure. It was designed for freight service, but not for the heavy work to which it has been put, of hauling trains up a steep grade at 12 miles per hour. The cylinder areas are in the ratio of 2½ to 1, whereas they ought to be about 2 to 1. The engine cuts off at about 17 ins. in high-pressure cylinder, whereas she ought to cut off at about 12 ins. Nevertheless this engine has shown a saving of 16.4% on coal and 13% on water as compared with a simple engine with 7% greater heating surface. The simple engine made ten round trips in 44.8 hours. The compound made ten round trips in 42 hours and pulled 180 tons more, thus she ran faster with a heavier load.

Concerning the merits of the two and the four-cylinder types, he said it was desirable to have the smallest cylinder surface possible in order to have the least condensation. Manifestly the four-cylinder type exposes more surface than the two-cylinder type. The value of reheating between the cylinders has been thoroughly established in stationary practice. A two-cylinder compound could be made to give a continuous expansion by having a reverse lever for each cylinder, but the gain would probably not be worth the additional complication. A compound locomotive to be economical should not cut off too late in the initial cylinder. If the steam is worked at full stroke, the expansion will all have to be done in the low-pressure cylinder.

Mr. Forsythe (Chicago, Burlington & Quincy) said the committee had made its tests under such variable conditions that it was difficult to tell what results were obtained. It was unwise to attempt to apply a long scientific test to a freight engine running "first in, first out." He hoped the committee would confine their further tests to a train running under the same conditions day after day. Many other tests have shown that compound locomotives give higher economy in freight service than in passenger service. Thus, if the test of the committee is correct, the gain by compounding in passenger service would be very small. These results contradict those obtained in many other tests.

The C. B. & Q. has recently purchased one ten-wheel Vauclain compound, which is hauling the Denver express, weighing 486 tons, at 41 miles per hour. It has also had in use for over a year a two-cylinder freight compound. The monthly performance sheets of this engine show average fuel consumption about 30% less than simple engines of the same class. The compounding of locomotives is in accordance with the progress made in other branches of steam engineering, and is destined, he believed, to become the prevailing practice. If he were spending his own money for rolling stock to-day, he would have no hesitation in purchasing compound locomotives, for freight service at least.

Mr. J. N. Barr (Chicago, Milwaukee & St. Paul) defended the variable conditions of the committee's test. It is known to a certainty that where the work is uniform the compound is superior to the simple engine; what is wanted is to know whether it can beat the simple engine in irregular service. The true way to test the compound now, however, is to put it at work without covering it all over with water-meters and indicators and dynamometer cars. Watch its results in daily service. If he could be sure of even 10% average gain in economy, he would compound all his locomotives as fast as possible. Such a saving would pay two or three times over any increased cost of repairs.

Mr. M. N. Forney said the compound locomotive builders had asked for odds in their favor in all the tests they had made. Pretending to test two locomotives of the same size and weight, they put about 2,000 lbs. more weight on the front truck of the

perience with two compounds for 2½ years was that they should be worked at their full capacity to give the best results. One reason why the Michigan Central had not ordered more compound locomotives was that they desired to get their equipment into the best possible condition for the World's Fair traffic, and didn't want any experiments. He had never claimed more than 12 to 18% gain in economy under the most favorable conditions. A careful test a short time ago covering several days and a run of 892 miles showed a saving in water of 7.4% and in fuel of 16%. The train for each engine was 45 cars. A larger exhaust nozzle is used on the simple than on the compound. With reference to repairs, the compounds have now been in service about 30 months. The firebox is standing well and the flues have a longer life than in the simple engine. The intercepting valve moves so seldom that it will never need repairs.

Mr. R. H. Soule (Norfolk & Western) said that in giving an order for 15 passenger engines recently they had ordered 5 Vauclain compounds, and tested them in comparison with simple engines of the same type. The compounds had heavier boilers to carry 185 lbs. pressure, larger wheels and 10 in. longer flues, the latter, however, he believed to be of little importance from an economical point of view. The engines were distributed on two divisions to obtain results from independent sources, and an accurate test was also made by the mechanical department. The average from all the locomotives in one month's service was a gain of 10% in water and 20% in fuel. On the strength of this result an order was at once given to the Baldwin works to build the remaining ten engines of the order as compounds.

In discussion of the general subject, Mr. Soule said that the economical use of higher pressure steam was a legitimate point to the credit of the compound locomotive. The limit of gain from higher pressure is reached sooner in the simple locomotive than in the compound, as has been fully proved. It is fair, therefore, to test the two at different steam pressures, provided each has the pressure best suited to it. Another point of very great importance is the increased capacity of the compound. If it will do the same work with less fuel, it will do more work with the same fuel. This is an advantage which will appeal strongly to the transportation departments. If they once find that they can get a little more work out of the compound, they will certainly demand it. That the compound has greater capacity admits of little doubt. It will start a heavier load since it uses the steam in larger cylinders, and after it is under way, it can either go faster or pull a heavier load, since it uses the steam to greater advantage. Early in the present century a Dr. Lardner proved that it was impossible for a steamship to carry enough coal to propel itself across the ocean. Mr. Soule thought that in a few years some of the remarks made in the discussion would sound much like Dr. Lardner's argument, for he felt as sure as possible that the compound locomotive was bound to come into general use.

CHICAGO DRAINAGE CANAL.

After extended consideration of the bids for the construction of the canal from Willow Springs to Joliet, as noted in our issue of June 16, the joint committee on engineering and finance of the Board of Drainage Trustees, Chicago, Ill., has reported in favor of letting contracts under proposition No. 2. The following is an abstract of the report:

The three propositions contemplate precisely the same channel for 14 miles over the rock section from Willow Springs to the head of the slope in the vicinity of Lockport, viz.: 160 ft. wide at the bottom with a depth of not less than 18 ft. of water, and with such a grade as to give a capacity of not less than 600,000 cu. ft. per minute at low water in Lake Michigan and when properly connected therewith. The general route to the head of the slope is the same, the alinement under Proposition 2 varying only to the extent of securing parallelism to and a fixed distance from the Illinois & Michigan Canal, and a point of terminus which will leave open for the present the route down the slope to the upper basin at Joliet. The route down the slope under Propositions 1 and 3 is to the west of the river and adjacent to the bluff, to the upper basin, some 4½ miles.

The total excavation is about 16,500,000 cu. yds., of which upward of 11,000,000 cu. yds. are solid rock. Under Propositions 1 and 3 it is proposed to extend the level of Lake Michigan to the upper basin in embankment, for the purpose of developing the water power, extending navigation, and clearing the bank of the channel of a portion of the spoil. Under Proposition 1, some 10,500,000 cu. yds. is to be hauled in cars to construct these embankments and fill in the area between the channel and the bluff; while in Proposition 3, the amount to be hauled is limited to 6,400,000 cu. yds. required to construct the embankments. Under Proposition 2 the material excavated is to be spoiled adjacent to the channel, and the water is to be conducted down the slope in the simplest and cheapest possible manner, all further work to be deferred until justified by the resources of the district, by commercial utility or Federal co-operation. No work on the slope was therefore invited under this proposition.

Under Proposition 1 the district was to provide railway and pumping plant, do the hauling for the contractor, keep the contractor's pits free from water, and execute that portion of the work in embankment and filling. Under Proposition 3 all the work was to be done by the contractor, ten sections being consolidated as one contract, so as to enable the proper railway plant to be provided. Under Proposition 2 the contractor was to dispose of his material in the simplest manner, and assume all responsibility.

The aggregate of the lowest bids under each proposition is as follows:

Proposition	1	$10,111,731.87
"	2	10,696,754.08
"	3	17,105,935.83

To ascertain the cost under each proposition there must be added the cost of right of way, structures and work not submitted to bid. No final estimate of structures has been submitted by the chief engineer, nor has the attorney been able as yet to furnish estimates of cost of right of way required. The necessary structures under Propositions 1 and 3 will be the same, and are estimated at $650,000, and a final estimate is not likely to exceed $750,000; on Proposition 2, $200,000 will cover all structures above the tail race. The right of way complete to the upper basin will be about the same, with some reductions in favor of Proposition 2. It may be assumed for present purposes at $900,000 for 1 and 3, and at $800,000 for No. 2. No estimate has yet been made for a tail race as instructed by the board. The matter may require much consideration before finally determined; meantime, a charge of $1,000,000 is assumed.

The cost of pumping and of transportation and the work at the lower end, to be done by the district under Proposition 1, will not be known until the work is completed. The material to be transported is some 70% in excess of that under Proposition 3, and if we assume that the bids under Proposition 3 are a measure of the cost of this work, then the cost will exceed that of No. 3 by $2,000,000 to $3,000,000.

Owing to the construction of the embankment, the character of the material entering therein, railway charges, flowage, water power, development, and other items of uncertain amount or incapable of estimate, 5% for contingencies should be added under Proposition 3. The contingencies will be greater under Proposition 1 on account of intimate business relations of a vexatious character with the contractors, and the large opportunities for litigation and extras; 8% will not be too much to allow for contingencies; Proposition 2 involves very little questionable or uncertain work, and is to be done entirely by the contractor. The contingencies are assumed at 2½%.

It may be said of Proposition 2 that about $1,500.000 of expenditure is for the slope from the main channel to the upper basin. The bids under Proposition 3, so far as indicating the cost of pumping, transportation, and the basin work under Proposition 1, have been called in question. In inviting proposals under No. 3, it was supposed that reliable information would be furnished as to these items. The lowest bidder for twelve sections under Proposition 1 appeared before the committee and submitted a proposal to do the transportation and pumping, the district to furnish the railway plant required. The figures submitted when extended to the entire work under No. 1, the gross cost of the plant included, and the slope paving added, aggregate $3,214,000. Allowing 5% for contingencies, the same as for No. 3, the aggregate for Proposition 1 is $15,672,000.

No such proposal can be entertained by the board, except as the result of competitive bidding 60 or 90 days hence, and it may be doubtful as to whether any other bidder will be in a position to contest the prices. In addition, the district must purchase $1,000,000 of railway plant for the use of the contractor.

The resources of the district by the end of 1896 are adequate to this object, but are not adequate to any additional purpose not strictly germane thereto, and which involves any considerable extra outlay. The extra cost under Proposition 3 prohibits any further consideration. The extra cost under Proposition 1 is not a matter of demonstration, and the difference of opinion in regard thereto has been so wide as to lead the committee to the conclusion that it is entirely problematical and unknowable until it is completed.

A wide difference of opinion exists as to the commercial benefits attendant upon the water-power scheme, a difference so great as to make it obvious that it should not be further considered at this time, especially as there are objects of prime sanitary importance on which all are agreed, and which will absorb the resources of the district for many years to come. All are agreed that it will possess utility. After the main channel is open and the market for water power is more apparent and closer to the investment, the resources will be more adequate to the development.

Proposition 2 calls for a channel to the head of the slope at Lockport at a total cost for this portion of the route of $11,500,000. The contractor is held responsible for progress and results only, and no complications are entailed with uncertainties as to cost. The farther extension down the slope is not now a pending question, and it may be given that careful study which the interests of navigation may demand and to which water power should be incidental. A properly located right of way will sufficiently protect the interests of the district in all future developments.

Considering the question in all its bearings, your committee regards Proposition 2 as the most feasible, as justified by the resources of the district and as fully satisfying the law, and therefore recommends the same to the board for adoption.

The board and the public are to be congratulated on the favorable prices bid for the work under a full competition, and the high character and responsibility of the bidders. The cost of the work is definitely settled as within the resources of the district, and the energetic prosecution of the same by the successful bidders may be assured in advance.

The recommendation of the committee has been adopted by the Board, and we give below the list of lowest bidders on the different sections, with their prices. A general description of the project, with maps and sections, was published in our issue of June 2. The prices for rock work, especially, are almost unprecedentedly low:

Sect.	Bidder.	Glacial drift Cu. yds.	Cts.	Rock excav. Cu. yds.	Cts.	Retain. walls Cu. yds.	$	Total.
1	Albert Harley	1,268,117	27	404,200	83½	54,129	1.37½	$754,325
2	McArthur Bros	821,392	28	372,814	91	38,859	2 00	646.968
3	" " "	492,444	27	661,796	86	14,690	2.00	732,024
4	" " "	418,556	27	678,260	86	16,764	2.00	729,841
5	Agnew & Co.	1,658,852	27	154,408	73½	82,947	1.48	522,141
6	" "	494,333	27	595,556	73½	21,138	1.48	602.487
7	" "	84,800	26	802,904	73½	7,168	1.48	622,791
8	" "	75,622	26	1,102,950	74¾	4,934	1.48	896,260
9	" "	173,397	26	1,232,065	76.9	2,741	1.48	906,574
10	E. D. Smith & Co.	119,419	25	1,210,513	80	2,240	2.00	1,002,745
11	Mason, Hoge & Co.	60,154	30¼	1,006,928	79¼	2,559	1.66	830,434
12	" " "	22,407	30¼	1,008,778	79¼	3,929	1.66	812,756
13	Agnew & Co	32,037	26	1,014,148	74¾	1,517	1.48	769,094
14	McCormick Const. Co.	166,537	20	979,588	73	19,946	2.00	788,298
	Total							$10,696,755

LIFE OF WHEELS OF CABLE CARS.

The following notes of the life of street-car wheels have been given to the "Tramway and Railway World," of London, by Mr. W. N. Colam, and refer to wheels which have been in service on the Edinburgh cable railways under his supervision. At the beginning of 1888, eight cars with four-wheel trucks or "bogies," and weighing over six tons each, were put in service on the first cable line in that city. The wheels are Whitney's light construction, cast-iron chill, supplied by the Metropolitan Carriage & Wagon Co., of Saltley, and the treads are not yet worn out, though the flanges are rather sharp. The mileage made by these wheels on the several cars, up to the end of April, 1892, was as follows:

Car No. 1	71,907 miles.		Car No. 5	71,651 miles.	
" 2	72,097	"	" 6	63,892	"
" 3	66,164	"	" 7	66,215	"
" 4	72,201	"	" 8	61,041	"

Records of mileage life of street car wheels on roads in this country, given in our issues of June 27 and Aug. 29, 1891, showed 22,000 to 25,000 miles in cable-car service with heavy traffic, and as high as 80,000 to 112,000 miles on some electric car lines.

The firm of W. S. Reed & Co. has been formed by Mr. W. S. Reed, of Chicago, and others, to carry on a general contracting business, making a specialty of waterworks, electric lighting plants, etc. Mr. Reed was connected with Moffett, Hodgkins & Clarke for several years

WORLD'S COLUMBIAN EXPOSITION; MACHINERY DEPARTMENT.

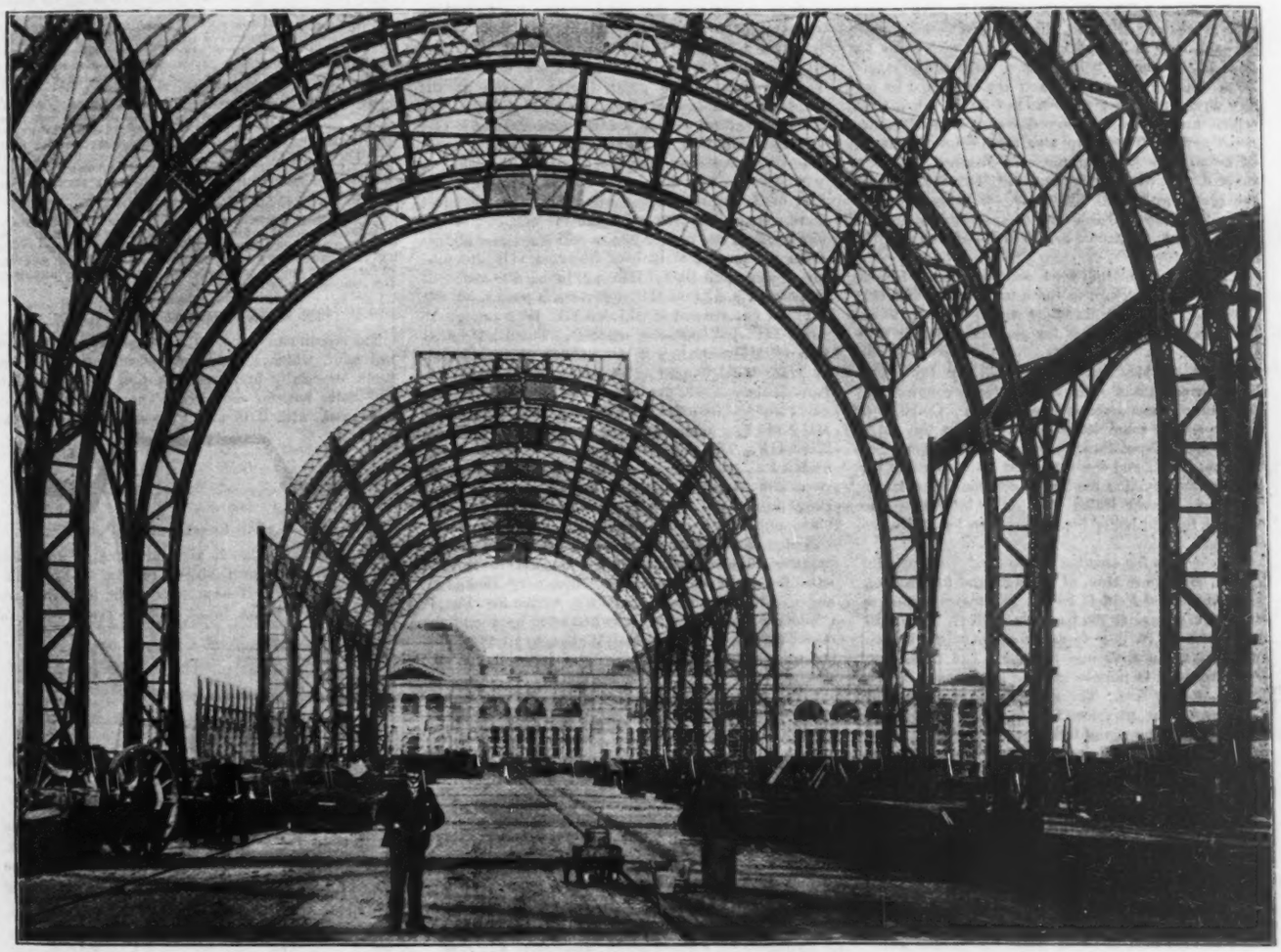
(With inset.)

Machinery Building.

This building is one of the large main buildings of steel construction, and is situated at the southern end of Jackson Park, forming the south side of the central plaza, its main front facing the Electricity Building and Mines and Mining Building. The Administration Building is in the middle of this central plaza, as shown by the map in our issue of Jan. 16. To the east of the Machinery Building is the Agricultural Building, separated by an arm of the grand canal, and having a connecting curtain across the end of the canal. The Machinery Building is 846 ft. long and 492 ft. wide, with an annex 560 ft. long and 560 ft. wide on the west, and a boiler house 100 ft. wide and 460 ft. long on the south. It has an area of 9.8 acres, and its cost, including the annex and boiler house (covering 6.2 and 1.1 acres respectively), is estimated at $1,200,000. The general appearance and style of the building were illustrated and described in our issue of Feb. 13. The architectural design of the main front is in the style of the Spanish renaissance, with details copied after those of noted buildings in Spain, and the treatment is very elaborate and richly decorated. The architects were Peabody & Stearns, of Boston, Mass., but the main ironwork construction was designed by the engineers of the Exposition. There are three main naves which run the entire length of the building and annex, and over each will be a traveling crane for handling exhibits, and also for carrying visitors while the Exposition is open. On each side will be a gallery 50 ft. wide, and there is an arcade on the first floor which permits of passage round the building under cover. At each corner is a pavilion, with a stairway to the galleries, and there are also intermediate stairways. The two main entrances are on the north and east sides, with numerous other entrances at the sides and ends and from the annex. The gallery level is 21 ft. 10 ins. above the main floor.

The foundations are of timber, according to the general plan described in our issue of March 5, and some of the typical forms of footings for columns are shown in the accompanying illustrations. The exterior framing is largely of wood, but the main construction is of steel. This steel construction was designed by Mr. E. C. Shankland, Engineer of Construction, and the details were all worked out by the engineers of the Construction Department. The structural work of all the buildings was designed in the Construction Department, the architects of the buildings having distinctly specified that they were to have nothing to do with the construction, although in the case of the Mines and Mining Building the use of the cantilever roof trusses was suggested by Mr. S. S. Beman, the architect, as noted in our issue of May 5. The general scheme of construction of the Machinery Building consists of three rows of three-hinged arch roof trusses the entire length of the building, forming three main naves. The design was made with a view to selling the roof trusses to railways after the close of the Exposition, for use as trainsheds or other railway buildings. The trusses give a clear width of 115 ft. 2 ins., and a clear headway of 93 ft. 6 ins. Over each row of trusses is a monitor or clearstory roof, and in the middle are three domed roofs supported by the arch trusses. The sides of the clearstories and the bases of the domes are fitted with louvres. This steel construction will have a two-story building 50 ft. wide on the north, east and south sides, the front of which will be of wood, with staff covering and decorative work (Eng. News, Jan. 16). There will be about 4,600 to 4,800 tons of steel in the main building, or nearly 5,000 tons, including the boiler and power house. The annex will be of timber construction. The principal contracts for the construction of the Machinery Building are as follows:

Iron work; Binder & Seifert and Cofrode & Saylor	$340,000
Carpentry; J. A. McGonigle	315,300
Painting and glazing; "	3,500
Lathing, plastering and exterior staff covering; Staff Decoration Co.	159,000
Roofing and skylights; P. L. Brigler	135,000
Architectural modeling, sculpture; M. A. Waagen, $2,510 and Robert Krauss, $1,500	4,000
Architectural modeling, pilasters; J. Evans & Co.	12,575
Total	$969,385



STEEL CONSTRUCTION OF MACHINERY BUILDING, WORLD'S COLUMBIAN EXPOSITION; E. C. Shankland, Engineer of Construction.

The most interesting work, of course, is the main steel building, the construction of which is very clearly shown by the drawings. It covers an area about 390 ft. by 742 ft., and is constructed of steel conforming with the general specifications adopted by the Construction Department (Eng. News, March 26). Only a few parts of minor importance are of wrought iron and cast iron. As already stated, it consists of three rows of arches, there being 46 of these main arches, and it is surmounted by three domes of equal size, 130 ft. 8 ins. diameter. The domes are covered with glass, and the main roofs have ample skylight area. Surrounding the building are galleries formed of steel girders and columns, and immediately adjoining it on the south side is the

boiler house, which contains 17 riveted roof trusses of 85 ft. span, resting on columns. The main arches are in two pieces, each half resting on a 5-in. pin bearing in the shoe at the floor level, and the two halves butting together on a 6-in. pin at the crown of the arch. The shoe bearings are connected by two tie rods 1⅞ ins. square, underneath the floor, with the ends forged into loops to embrace the shoe pins. The sides of the arch truss are vertical to a height of 35 ft. 11 ins., and thence curve with an inside radius of 57 ft. 7 ins. The radius on the center line is 60 ft. 11 ins. The clear width inside each truss is 115 ft. 2 ins., and the clear height 93 ft. 6 ins. The trusses are 6 ft. 9 ins. deep and 24 ins. wide. The shoe pins are 5 ins. diameter, and the top pin 6 ins. The top and bottom chords are parallel, and are built up of four angle irons, with lattice bars on the sides, and a 24-in. plate on the top of the upper chord and bottom of the lower chord, as shown. The diagonal members are of angle irons and latticing. At the bottom and crown of each arch a ⅜-in. solid web plate about 8 ft. long is used. The rivets are all ¾-in. diameter. The base plate of each shoe is 2 ft. 8 ins. by 2 ft., with holes for four 1½-in. anchor bolts. These trusses are spaced 50 ft. 8 ins. apart c. to c., and are connected by lattice girder purlins 4 ft. deep and 50 ft. 8 ins. long, which are braced by curved struts also of lattice construction. There are also steel columns outside of as well as between the arch trusses. The distance c. to c. of these columns is 130 ft. 8 ins. across the center arch, and 130 ft. 0½ in. across each of the side arches. The height to base of dome is 107 ft. 2¾ ins., and extreme height to top of dome 160 ft. 8¾ ins.

The contract for this work was awarded to Binder & Seifert, of Chicago, in the latter part of October, 1891, and the detail drawings were got up by them. They placed the contract for manufacturing it with Cofrode & Saylor, of Philadelphia. The steel was rolled by the Reading Rolling Mill, the Pottstown Iron Company, and other works. On account of the very short time given for completion, Cofrode & Saylor sublet some parts of the work; the three domes to the New Jersey Steel & Iron Company, of Trenton, N. J., and the plate and lattice girders for galleries surrounding the building to the Penn Bridge Company, Beaver Falls, Pa. At a later date the contract for the boiler house was also let to Binder & Seifert.

The contract for erection of the steel work was let to F. J. McCain & Bro., of Chicago, and the erection was commenced Feb. 1, 1892. The traveler used is 40 × 50 ft. square at the base, and 145 ft. high, with two booms 50 ft. long to reach out over the arches and raise the purlins into position. The front side of the traveler is plumb, but the back has a batter of 1 in. to the foot. The hoisting engine is set on the back of the traveler, and has two drums and four spools. The main falls for lifting the arches are ⅝-in. steel wire cables with treble blocks. Each arch consisted of two halves, and each half was delivered in three pieces, which were riveted together on the ground. One half arch was lifted and put on edge, and the lower end then connected to the shoe bearing by a 5-in. pin. Ropes were attached to the free end, and the half arch raised into position, turning on the pin in the shoe as a pivot, and secured until the other half arch was raised, when the upper ends were connected by the 6-in pin. The complete arch was then held in place, while the purlins were raised by the boom and secured, and the curved struts and lanfern or clearstory trusses put in. The traveler was then ready to be moved back to raise the next arch. It took about 15 minutes to move the traveler into its new position, and if everything went well the contractors were able to raise one arch and all the necessary purlins, struts, etc., for one panel in a day, with a gang of 60 to 70 men. This day's work represented about 100 tons erected, each arch complete weighing about 45 tons.

Machinery Exhibits.

Exhibitors will not be charged for space. A limited amount of power will be supplied free, and any power in excess will be supplied by the management at a fixed price. Any single piece or section of any exhibit of greater weight than 30,000 lbs. will not be accepted if machinery is required for its installation. If exhibits are intended for competition it must be so stated by the exhibitor, or they will be excluded from examination for award. The steam pressure supplied will be 150 lbs. per sq. in., and exhibitors requiring a lower pressure can obtain it by using a reducing valve. The line shafting will make 150 and 300 revs. per minute, and will be placed 16 ft. from the center of shaft to floor of building. The driving pulleys on the main line of shafting must be supplied by exhibitors, and must be in halves and limited to 36 ins. diameter. The main lines of steam, water and sewer pipes will be provided, but all connecting pipes, valves, etc., will be supplied by the exhibitors, and no steam or water pipe will be allowed to cross over the passageways except as specially provided in certain cases. The water pressure will be that due to a head of 200 ft., or about 86 lbs. per sq. in. The general reception of articles will commence Nov. 1, 1892, and no article will be admitted after April 10, 1893. The general classification is divided into 11 groups and 86 classes. Mr. L. W. Robinson, U. S. N., is Chief of the Department of Machinery.

It is stated that the great engine for furnishing motive power will be a quadruple expansion engine of 3,000 to 4,000 HP., built by the E. P. Allis Co., of Milwaukee, Wis., and forming a part of that company's exhibit. The great Corliss engine at the Centennial Exposition at Philadelphia, in 1876, was a double-acting vertical engine with cylinders 44 × 120 ins., and was of 1,400 HP. One of the large traveling cranes running the length of the building will be supplied by the Yale & Towne Manufacturing Co., of Stamford, Conn. According to a published statement by Mr. J. C. Slocum, the engineer of the power plant, the motive power will aggregate 30,000 HP., the largest plant ever installed. Of the supply at command 19,000 HP. will be used to generate electric lights, 3,000 HP. for electric power, 31,000 HP. for compressed air, 21,000 HP. for pumps, and 4,000 HP. for operating exhibits. The E. P. Allis Co., of Milwaukee, will put in one vertical engine of 3,000 HP.; Fraser & Chalmers, of Chicago, will furnish six engines, the largest one of the four-cylinder, triple expansion, horizontal type, of 1,000 HP., and five others with an aggregate capacity of 2,100 HP. The Bethlehem Iron Co., of South Bethlehem, Pa., will make an extensive exhibit, including steel rails, a battle-ship shafting 125 ft. in length, guns, projectiles, an armor-plate ingot weighing 100 tons, and various naval appliances. The company will also erect a full-size model of its 125-ton steam hammer, said to be the largest in the world. It will span the main avenue of the Machinery Building, and will rise to a height of 90 ft. At the last Paris exhibition great attention was attracted by a similar model shown by the Creusot Works, but representing only a 100-ton hammer. The following is an abstract of the general classification:

Group 69.—Motors and Apparatus for the Generation and Transmission of Power; Hydraulic and Pneumatic Apparatus.—Boilers and all steam and gas generating apparatus for motive purposes. Water wheels, water engines, hydraulic rams. Steam, air and gas engines. Apparatus for the transmission of power, shafting, hangers, belting, pulleys, couplings, clutches, cables, gearing. Transmission of power by compressed air, etc. Water filters, pumps and apparatus for lifting and moving liquids, for moving and compressing air or gas. Pumps and blowing engines, blowers and ventilating apparatus. Hydraulic presses, freight elevators and lifts. Traveling cranes and derricks. Beer engines, soda water machines, bottling apparatus, corking machines. Iron and other metallic pipes, tubes and fittings, stop valves, cocks, etc. Diving apparatus and machinery. Ice machines. Refrigerating apparatus.

Group 70.—Fire Engines; Apparatus and Appliances for Extinguishing Fire.—Engines, Hose-carts and hose. Ladders and escapes. Stand-pipes, etc. Chemical fire-extinguishing apparatus.

Group 71.—Machine Tools and Machines for Working Metals.—Small tools for machinists' use, drills, taps and dies, gages, etc. Squares, rules and measuring tools. Steam hammers, trip-hammers, drop forging and swaging machines, hydraulic forging, etc. Planing, drilling, slotting, turning, shaping, milling, punching and cutting machines. Wheel-cutting and dividing machines.

Group 72.—Machinery for the Manufacture of Textile Fabrics and Clothing.—Machines for the manufacture of silk, cotton, linen and woolen goods. Worsted-working machinery and appliances. Machines for the manufacture of rope and for twine-making and for miscellaneous fibrous materials, for paper-making and felting, for the manufacture of india rubber goods, and of mixed fabrics. Machines used in the manufacture of tapestry, including carpets, lace, floor-cloth, fancy embroidery, etc. Sewing machines for heavy materials. Machines for preparing and working leather, and for making boots and shoes.

Group 73.—Machines for Working Wood.—Direct-acting steam sawing machines, with gang saws, band saws, circular saws. Sawmills and sawmill tools. Wood-working machinery for sawmills. Wood-working tools and minor appliances for sawmills. Planing, sawing, veneering, grooving, mortising, tonguing, cutting, molding, stamping, carving and cask-making machines, etc.; cork-cutting machines. Lathes for wood work and machinery for the manufacture of matches, toothpicks, etc.

Group 74.—Machines and Apparatus for Type-Setting, Printing, Stamping, Embossing, and for Making Books and Paper Working.—Steam power presses. Hand-printing presses. Job presses. Hydraulic presses. Ticket printing and numbering machines. Type-casting and setting machines. Linotypes. Electrotyping and stereotyping. Bookbinding machinery. Printers appliances and machinery. Type specimens. Folding, stamping, addressing and embossing machines.

Group 75.—Lithography, Zincography and Color Printing.—Lithography; tools, materials and appliances. The various methods of lithography, crayon, pen and ink; engraving, brush work, color printing, etc. Transferring, printing. Zincography. Color printing; historical illustrations from the 16th century to the present time. Modern wood engravings. Intaglio engraving, printed at one impression; i. e., from the plate rubbed in different colors. Printed from several plates. Stenochromy. Cromo lithography. Wax process, etc. The modern photo-mechanical processes applied to color printing.

Group 76.—Photo-Mechanical and Other Mechanical Processes of Illustrating, Etc.—Relief, half toned, collographic, photo-mechanical and mechanical processes. Photolithography. Etchings on glass. Drawings for process work. Application of the photo-mechanical processes in the industrial arts.

Group 77.—Miscellaneous Hand-Tools, Machines and Apparatus Used in Various Arts.—Machines for making clocks, watches, watch cases, jewelry, buttons, pins, needles, etc. Wire-working machinery. Machines for laundry work, for making pharmaceutical products, etc. Emery and corundum wheels. Street rollers, sweepers and sprinklers. Steam gages, oil cocks and all kinds of appliances used in connection with machinery. Dynamometers. Testing machines.

Group 78.—Machines for Working Stone, Clay and Other Minerals.—Stone-sawing and planing machines, dressing, shaping and polishing, sand blasts, glass-grinding machines, etc. Brick, pottery and tile machines. Machines for making artificial stone. Rolling mills and forges—roll trains, hammers, squeezers, engines, boilers and other driving power; heating furnaces (coal and gas), special machines for shaping metal, such as spike, nail and horseshoe machines; tire mills, etc.

Group 79.—Machinery Used in the Preparation of Foods, Etc.—Mills for the preparation of cereals. Sugar-refining machines. Confectioners' machinery. Oil-making machinery; presses and stills. Mills and machinery for spices, coffee, etc. Evaporating machinery for condensing milk, etc.

THE REINFORCED RAIL JOINT.

The accompanying cuts represent a new form of rail joint, which appears to present some good features, especially in its combination of bridge plate and splice bars in one piece. The plate is made of best steel, with 0.08 to 0.1% carbon, rolled to the

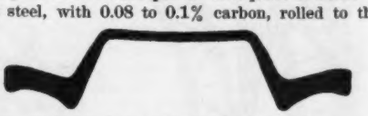


Fig. 1. The Reinforced Rail Joint.

shape shown in Fig. 1, and then heated and bent into the finished form, shown in Fig. 2, by a machine. Fig. 3 is a cross-section of the joint in place on the rail. It is the result of some years' study of

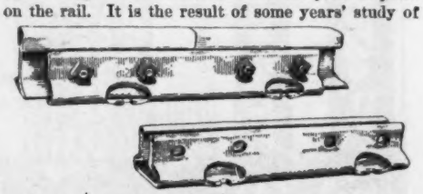


Fig. 2.

the rail joint problem, and is claimed to be one of the best devices for a rail joint in point of strength, safety and economy. In placing and replacing, the joint slides on and off the rail with ease, and being

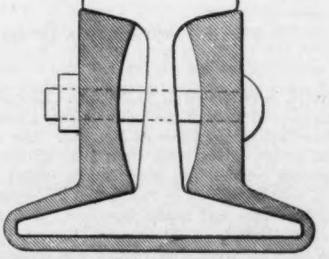


Fig. 3. Reinforced Rail Joint.

made with a flare to the sides, when it is bolted tight to the rail its elasticity acts as a nut lock, and no other lock is needed. The two small flat projections are slotted for spikes to prevent creeping of the track. For rails 4½ and 5 ins. wide over the base

the weight and cost per joint are 40 lbs. and $1.15 for the former, and 44 lbs. and $1.30 for the latter. The joint is being put on the market by the Reinforced Rail Joint Co., 53 State St., Boston, Mass. President, J. Francis LeBaron; Vice-President and General Manager, D. A. Chapin; Secretary, Henry O. Cushman. The company will open an office at Chicago, in charge of C. P. Cushman. The joint is now being manufactured by the New Jersey Steel & Iron Co., of Trenton, N. J., and is being tried on some eastern railways, including the Boston & Maine R. R., Central Vermont R. R., Long Island R. R., Old Colony R. R., and Manhattan Elevated Ry.

VARIATIONS IN CEMENT TESTING SIEVES.

By L. C. Sabin, U. S. Asst. Engr.

Although in the last few years a considerable advance has been made toward uniformity in methods of testing cement, the results obtained by different experimenters are still not comparable to any great extent. This is due largely to one or both of two causes. Variations may exist either in the apparatus used or in the methods of manipulation. The experimenter may or may not be aware of these differences. In considering means of obtaining greater uniformity in testing both these elements of variation must receive attention.

It is here proposed to consider the test for fineness which, beside being one of the simplest tests to make, is well recognized as being one of considerable importance. The second cause of incomparability of results will be first taken up. Fortunately, in this test, no serious errors need occur from faulty manipulation. It has been stated as a rule that sifting should be continued until a white paper placed under the sieve detects no particles passing. To one who has tried it this rule is known to be impracticable, but the sifting may be done in a reasonable length of time with a resulting error of not more than 1% or 2%. For instance, after sifting 0.1 lb. of a very fine German cement for 14 minutes with a No. 100 wire cloth sieve, whose meshes were rectangular and about .006 in. by .007 in., 94.3% had passed the sieve and it required over 22 minutes more to get another 1% through. Likewise in using an English cement 84.8% had passed the same sieve in 9 minutes, and 23 minutes longer were required to obtain 85.8% passing. Here, then, is a test whose accuracy depends largely on the apparatus used in its performance. To illustrate the indetermination existing in cement literature concerning sieves it may be recalled that English writers have often designated a sieve as of so many "holes per square inch," without giving size or shape of the holes or manner of construction of the sieve. It may be guessed that the sieve is of wire cloth and the holes therefore approximately rectangular, but the designation is evidently satisfied if the holes are infinitesimally small and of any shape. In some countries standards have been adopted for sizes of wire of which sieves should be made, and in such countries writers may properly refer to a sieve as of so many meshes per square unit provided they know it to conform to the standard.

For use in testing the cement for the 800-ft. lock now constructing at St. Mary's Falls Canal, Mich., a set of apparatus was received from a prominent manufacturer. Five wire cloth sieves were included, marked Nos. 20, 30, 50, 80, and 100. Upon counting the meshes per linear inch each way were found to be as in Table 1.

Table 1.—Meshes Per Linear Inch.

No. of sieve.	Across web wires.	Across woof wires.
20	20	19¼
30	30	28¾
50	50	37¼
80	80	67
100	100	89

Sieves whose meshes should be more nearly accurate to count were asked for to replace the last four numbers. The manufacturer said no complaint had ever been made before, but sent four sieves of the same make whose meshes counted as given in Table 2.

Table 2.—Meshes Per Linear Inch.

No. of sieve.	Across web wires.	Across woof wires.
30	30	28¾
50	50	34⅝
80	80	67
100	100	90

The No. 100 was a trifle better as to count, but the meshes appeared to be more irregular than those of the first No. 100.

Of the third lot received the last three were of a different style. It was explained that they had been procured of "a party in New York who claimed to have had the cloth made especially for such work." Table 3 gives the results for this lot.

Table No. 3—Meshes Per Linear Inch.

No. of sieve.	Across web wires.	Across woof wires.
30	30	28⅝
50	50	47
74	80	80
100	101	88¼

The diameters of the wire in some of the sieves were measured with a microscope fitted with a micrometer attachment. Results are given in Table 4.

Table No. 4.

No. of sieve.	Meshes per in. Across web.	Meshes per in. Across woof.	Diameter of wire, inches. Web. No.	Web. Diam.	Woof. No.	Woof. Diam.	Diff. in inches.	Mean size, opening. Web wires.	Woof wires.	Diff.	i/j Ratio.
20	20	19¼	4	.0185	4	.0169	.0016	.0315	.0337	.0022	.93
30	30	28¾	4	.0119	4	.0119	.0000	.0214	.0229	.0015	.93
50	50	47	2	.0082	2	.0083	.0001	.0118	.0130	.0012	.90
74	80	80	2	.0054	1	.0054	.0000	.0071	.0071	.0000	1.00
100	101	88¼	3	.0040	3	.0040	.0000	.0059	.0073	.0014	.80

The "ratio" in the last column is that of the web wire intervals to the woof wire intervals.

It is noticed that the diameters of the web and woof wires in the No. 20 sieve differ by a very appreciable amount. This may be due to the flattening of the web wires in course of the manufacture of the cloth.

The irregularity of the meshes was tested by measuring the width of adjacent openings. In the No. 20 sieve one mesh was found whose width was but 64.2% of the width of an adjacent one, and in the No. 100 sieve the widths of two adjoining meshes were as 3 to 4. These measurements were made before the sieves had become injured by use.

If we assume that the No. 50 sieve of Table 2 having 34 2-3 meshes per linear inch across the woof wires to be made of wire having diameter .0083 in., the meshes, instead of being .012 in. square, would be .012 in. by .020 in., or only three-fifths as wide as long. That the number of meshes per linear inch should be correct is thus seen to be of greater importance than would at first appear.

The Committee of the American Society of Civil Engineers, in their report on a "Uniform System for Tests of Cement," recommended the use of wire of Nos. 28, 31, 35, 37 and 40 "Stubbs' wire gage." This seems to leave the diameter of the wire uncertain on account of the difficulty of determining what "Stubbs' gage" really is. Mr. C. P. B. Shelley, Professor of Machinery, Kings College, London, says of wire gages: "Of late years careful comparisons have more than once been independently made with a view to ascertaining the standard value of these incongruous systems, but the discrepancies in the results only prove what might have been predicted, viz., that errors have crept in and that those which profess to be alike differ among themselves, whilst there exists no satisfactory means of rectifying these errors." (Ency. Brit., Vol. X., p. 110). Manufacturers urge their customers to "give dimensions and not numbers." Trautwine's "Pocket-book" says: "As Mr. Stubbs makes various English gages the term 'Stubbs' gage,' by itself means nothing. Generally, however, in our machine shops it applies to the Birmingham gage." The writer has been informed by members of the committee that the term "Stubbs' gage" does mean Birmingham gage. This, however, does not help the matter much, because Nos. 37 and 40 are not given in the Birmingham gage. It has so far been impossible for the writer to determine what is the diameter of the wire corresponding to "Nos. 37 and 40, Stubbs' wire gage."

In Table 5 are given in decimals of an inch the diameters of wire corresponding to Nos. 28, 31, 35, 37 and 40 in a few of the many "standard" gages, and below are some actual diameters of wire as found in cloth purporting to be made of wire of corresponding number. It should be stated that manufacturer "A" does not claim to be using "Stubbs' gage," while "B" does.

As a result of this labyrinth of indetermination, it is impossible to know, except approximately, the size of holes in sieves that have been used and are being used. An observer can measure and determine the dimensions of the holes in his own sieve, but he cannot know certainly within a large percentage the sizes of the holes in sieves used by other experimenters with whom he may wish to compare.

It may not seem out of place, then, to endeavor to formulate what is desirable in a sieve and then to inquire how it may best be obtained. It is thought that the following specifications define an ideal sieve:

1. Holes of uniform size and shape throughout.
2. Sides of holes very smooth.
3. Spaces between holes of such size and shape that particles will not easily rest there.

A sieve may deviate from the ideal and still be a good one. As regards uniformity, it is evident that the largest holes determine the character of the sieve. For example, a sieve with half its holes 0.01 in. in size and the other half 0.02 in. in size would, if used long enough, separate the cement exactly as it would if all its holes had been 0.02 in. in size. If even a very small percentage of the holes are larger than the normal it seriously impairs the accuracy of the sieve by introducing an indetermination. On the other hand, holes smaller than the normal have no greater objection than that, as the sifting proceeds, they become mere spaces between the real or larger holes, and as such do not fulfill the third specification. Therefore, while larger holes are not admissible, smaller holes may be allowed to the extent of say 10%, and the sieve still be good and accurate.

Concerning the second specification, the side of the holes must be so smooth as not to allow particles of cement to adhere and thus clog the hole. The third requirement is for convenience, but might require consideration if the style of sieve were changed.

Table 5.—Diameter of Wire in Decimals of an Inch.
(From Brown & Sharpe's Catalogue.)

No.	B. & S.	Stubbs'.	W. & M.	T. I. Co.	G. W. P.	Old E.
28	.012841	.014	.016	.016	.017	.0165
31	.008928	.010	.0135	.013	.0146	.01225
35	.005614	.005	.0095	.0095	.0109	.009
37	.004453	....	.0085	.0085	.0095	.0085
40	.003144	....	.007	.070	.0078	.0045

Key.—"B. & S.," Brown & Sharpe; "Stubbs," Birmingham, or Stubb's; "W. & M.," Washburn & Moen Mfg. Co.; "T. I. Co." Trenton Iron Co.; "G. W. P.," Geo. W. Prentiss; "Old E.," Old English, from brass manufacturers' lists.

Actual Diameter of Wires in Inches.

No. of Sieve.	Manufacturer A.	Manufacturer B.
20	.0185	....
20	.0169	.....
30	.0119	.....
50	.0091	.0082
74	.....	.0054
100	.....	.0040

A punched metal plate has been suggested as a substitute for wire cloth, and is discussed editorially in Engineering News for Sept. 26, 1891. An objection is there made to a change in the shape of the hole. The writer does not see the validity of this objection. The crushed quartz, recommended by the Am. Soc. C. E. committee, and which is coming into use for sand tests in this country, has practically no rounded grains, and it is not probable that the shape of the grains passing round holes would be materially different from those passing square holes. If it is argued that there would be difficulty in adjusting the size of opening to correspond with the sizes of square holes in current use, it may be returned that sieves now in use purporting to be of the same size of mesh differ so widely that they are hardly worth serious consideration in any changes which may seem desirable. A punched metal plate could no doubt be made to fulfill the first specification almost perfectly and would be less likely to injury from use than a wire sieve, but the former might not so fully comply with the second and third requirements. On the other hand, a wire cloth sieve readily complies with the last two, but, as has been seen, is apt to be wide of the mark on the first. The writer has been informed, however, by Messrs. Edward Darby & Sons,

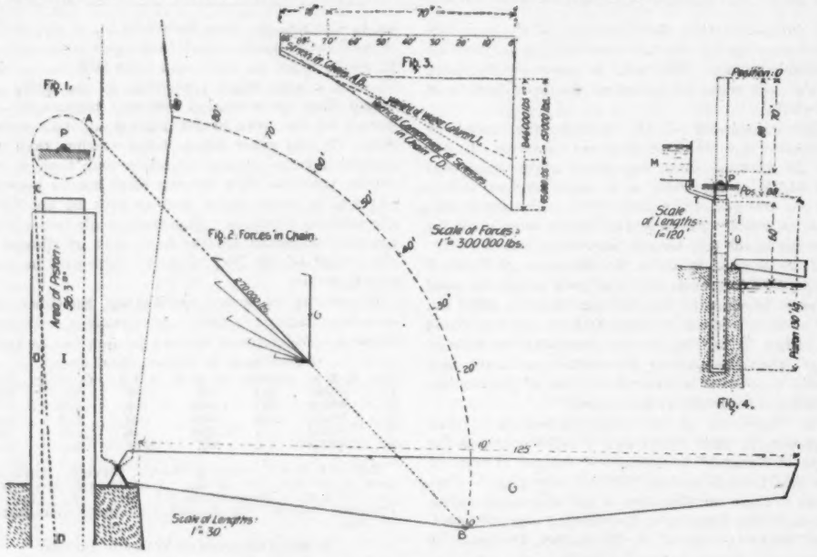
wire manufacturers, of Philadelphia, that they are prepared to make a "cloth accurate in the number of meshes to the inch" at an advance in price of about 30% over the ordinary cloth. It is believed that, though there are possibilities in the punched metal plate, yet the wire cloth should be adhered to, if sufficient accuracy can be obtained by its use.

Finally, the question of sieves might be put upon a better basis if the following things were done: 1. Manufacturers of wire cloth should be encouraged to make cloth which will fulfill as nearly as may be the foregoing specifications; and, 2, observers should be urged to designate their sieves by the size and shape of the holes.

PROPOSED METHOD FOR OPERATING A VERTICAL LIFT DRAWBRIDGE.

We have received from Mr. Charles Steiner, of Minneapolis, Minn., the accompanying drawing of a design for a hydraulic lifting apparatus for a drawbridge of 250 ft. clear span, with two wings each 125 ft. long. The drawing shows the proposed apparatus for operating only one wing, that for the other wing being precisely similar.

Fig. 1 represents the wing (G) in horizontal and in



PROPOSED METHOD OF OPERATING DRAWBRIDGE

vertical position, and two fixed pulleys (P), resting on an iron tower on the top of the masonry abutment. In the fixed watertight case (O) another watertight case (I) slides between guide rollers, and two lifting chains (B A C D) run from the middle of the bridge girders over pulley (P) and to the iron case or plunger (I), which forms the balance weight of the empty bridge. Another and stronger chain of eyebars, not shown in the drawing, connects each side of the half-span with the top of the tower, and serves to carry the loaded bridge when in its horizontal position.

Fig. 2 is a diagram of strains in the chain (A B) when moved 10, 30, 50, 70 and 88 ft. to the upright position. These strains are also shown in Fig. 3, where the additional strains from friction on the pulley are added, and the forces reduced to the vertical direction. The weight of a water column of 35 sq. ft. area is there shown by a straight dotted line. The plunger is 56.38 sq. ft. in section.

Fig 4 shows the balance piston (I), 130 ft. in length, in the two extreme positions, 88 ft. apart, and the water tank (M), in which the hydraulic power for one lift is accumulated. When the bridge is closed the piston is kept in the upper position by the water column in cylinder (O), which rises 60 ft. above the water level of the river, the piston being suitably ballasted. By discharging from (O) a water column weighing 95,000 lbs., corresponding to a height of 43.5 ft., the plunger will go down in addition to this height, according to the dotted straight line, until a further quantity of 151,000 lbs. of water is replaced, and will then gradually stop. This position of the bridge will, as a rule, afford sufficient opening for the passage of the vessels, but, whenever a total opening is required, the water level may be lowered again until the plunger reaches the lower extreme position shown.

By filling the case (O) from the tank (M), the plunger is returned to its upper or extreme position and the bridge is closed. By a proper regulation of the inflow and outflow of water through the valves the movement of the bridge can be made as quick as desirable and is completely under control. No gearing is used, and the motive power is claimed to be reduced to a minimum. The water tank (M) may be a small storage tank connected with the city water supply system, or may be fed by a pump near the bridge.

THE POLLUTION OF STREAMS.*

Among the obstacles which have obstructed the progress of efforts to prevent the pollution of streams are the following:

(1). Individual selfishness and municipal parsimony in dealing with the questions of public water supplies and disposal of sewage.

(2). The various standpoints from which the subject is approached, such as that of the engineer, health officer, chemist and the biologist.

The engineer seeks for the best point or points for an outfall toward which his sewer mains shall converge, and afford him proper levels in his laterals. The health officer very properly is concerned in seeing that this outfall shall be so located as to at least prevent a local nuisance or injurious effects to the residents of his own municipality. The chemist thinks that if a river water in organic constituents is no worse than many natural waters that it is fairly safe. The biologist is inclined to settle the purity of a stream offhand by the number of living bacterial forms he finds present.

Passing over the spread of cholera by means of water as a generally accepted fact, the dissemination of typhoid fever may be said to be the crucial test of water pollution in temperate climates.

Taking a series of years, the pollution of even relatively immense bodies of lake water, which, having no regular flow, are liable to carry sewage to a water intake, will, at certain seasons, and with winds moving sewage toward the point of supply, cause outbreaks of typhoid of a more or less epidemic character. That in cities obtaining practically all their drinking-water from a public supply whose source is beyond the possibility of contamination, typhoid fever will practically disappear from the list of causes of mortality.

In addition to sewage there are other serious pollutions to streams, such as washings from cultivated lands, barnyards and notably vegetable matter.

But speaking generally from the sanitary standpoint, those streams possessing frequently excessive amounts of vegetable organic matter of a humic character have come to be recognized as in themselves wholesome, and to be placed in northern latitudes in a very different category from many other streams, showing much less impurity of this kind. As illustrations, analyses of three different waters are given below. The first is from an inland river, the Scugog, above Lindsay, Ont., taken from under the ice in February, the river flowing from a lake of considerable extent with swamp along its borders. The second is from an artesian boring through blue clay to a water-bearing sand above Hamilton shale. It is used as a public water supply. The third is from the Chicago public water supply, after a week of southwesterly winds, the Chicago river being 2 ft. higher than the lake. The analyses are in parts per million, as follows:

	No. 1.	No. 2.	No. 3.
Free ammonia	0.72	0.40	0.011
Albuminoid ammonia	0.38	0.08	0.088
Chlorine	6.00	202.00	1.888

There are a variety of opinions regarding the pollution and purification of rivers and lakes, but whatever views may be held on the various points coming up for consideration in connection with the disposal of the sewage of any individual municipality, the following three general propositions will, I have no doubt, meet with general acceptance:

(1.) That, as is stated in "An Act to Protect the Purity of Inland Waters," passed by the Legislature of Massachusetts in 1888, state boards of health should have the general oversight and care of all inland waters, should recommend measures to prevent the pollution of such waters, and to remove substances and causes of every kind which may be liable to cause pollution thereof. Or, as stated in the Public Health Act of Ontario:

Whenever the establishment of a public water supply or system of sewerage shall be contemplated by the council of any city, town or village, it shall be the duty of the said council to place itself in communication with the Provincial Board of Health, and to submit to the said board, before their adoption, all plans in connection with the said system.

It shall be the duty of the Provincial Board of Health to report whether, in its opinion, the said system is calculated to meet the sanitary requirements of the inhabitants of the said municipality; whether any of its provisions are likely to prove prejudicial to the health of any of the said inhabitants, together with any suggestions which it may deem advisable; and to cause copies of the said report to be transmitted to the minister of the department to which the said Provincial Board of Health is attached, and to the clerk of the Municipal Council and the secretary of the local Board of Health of the district interested.

No sewer, or appliance for the ventilation of the same, shall be constructed in violation of any of the principles laid down by the Provincial Board of Health, subject to appeal to the Lieutenant-Governor in Council.

The law of Massachusetts makes practically the same provision.—Ed.

(2.) That those municipalities situated within the same drainage area, where streams, polluted with sewage of one municipality, become or are likely to become sources of public water-supply for other municipalities, be by law united by an Order-in-Council to the Governor upon the report of a State or Provincial Board into a Rivers Conservancy Board, said board to act in conjunction with the State or Provincial Board, in the consideration of town water-supplies and sewage disposal within the area.

(3.) That in cases where river, lakes, etc., form interstate, provincial, or international boundaries, or where the course of such passes from one state or province into another, that interstate or interprovincial action be encouraged; and that in those cases where streams come within the control of a Federal Government that such Government should urge interested states and provinces to similarly appoint Conservancy Boards.

Among other conclusions, which I believe the facts warrant us in drawing; but upon which there may be differences of opinion, are the following:

(1.) That no water into which sewage flows can at all times, and under all circumstances, be considered safe for domestic supplies.

(2.) That there are streams and lakes, such as the great lakes, of such enormous volume that it is as yet possible to pour sewage into them and yet use their waters for public supply; but that this can only be done in those cases where such distance intervenes as shall allow time for the natural purification of water to have completed itself, and that this can only be known after careful and extended experiments, chemical, biological and bacteriological, in addition to observations of currents and temperatures, carried out in different seasons and under the varying conditions of flood and drought.

(3.) That where ordinary streams in well-settled districts are required to be used for public purposes owing to the lack of other sources of supply, that every effort be made by Boards of Health to have the gathering grounds and sources of supply kept free from all forms of animal pollution; and hence it is urged that modern methods of sewage disposal, notably those of intermittent filtration, or precipitation with subsequent filtration, be forced upon the attention of cities and towns contemplating having sewerage works.

(4.) That few river waters are fitted for use without sedimentation and filtration either by natural sand filters or some mechanical filter, as those through sand operated under pressure.

* Brief abstract of a paper by P. H. Bryce, M. D., Secretary of the Provincial Board of Health of Ontario, read at the National Conference of State Boards of Health, Lansing, Mich., June 6, 1892.

WATER-WORKS AND SEWERAGE OF THE CITY OF WARSAW.

The following facts on the water supply and sewerage of the city of Warsaw (population about 500,000) we abstract from the "Gesundheits-Ingenieur:"

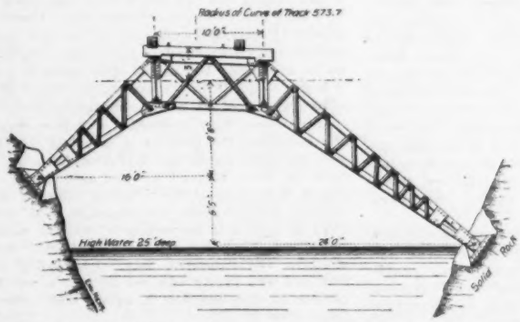
A pumping station with a 36-in. suction main of 2,503 ft. length and two pumping engines of about

4,500,000 gallons daily capacity each supplies the water filtering plant situated at Koschiki, a suburb of Warsaw, through a 30-in. force main of 12,010 ft. in length. The filtering plant is covered, and consists of a sand-filter and a settling basin of 15,110 sq. yds. area. The clean water reservoir has a capacity of nearly 3,000,000 gallons. There is a water tower 133 ft. high, with a diameter of 34 ft. From the tower a conduit 33,920 ft. long, consisting partly of concrete, partly of pipe, leads to the lower quarters of the city. The higher parts are supplied by two force mains of 11,900 ft. length. There are 100 hydrants and valves in use at present.

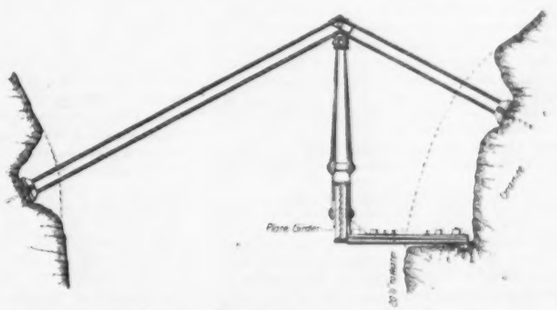
The sewerage system of the city has a pipe length of 129,000 ft. A part of the sewerage is carried into the Vistula River about 14,000 ft. below. The growing demands of the city will necessitate the extension of the water-works and sewerage system in the near future. To that purpose the pumping and filtering station will be supplied with one more engine each. The filtering and settling basins are to be enlarged. Several new intakes will also be added to the suction main. The extension of the water-works and sewerage system of the city will necessitate an expenditure of $3,225,000, approximately.

BRIDGING CANYONS LENGTHWISE.

A paper with this title, by Mr. H. V. Hinckley, was presented at the recent annual convention of the American Society of Civil Engineers, and described briefly two cases in which such construction had been adopted. The first is in the Apache Canyon of the Rio Galisteo, on the main line of the New



BRIDGE IN APACHE CANYON, NEW MEXICO; ATCHISON, TOPEKA & SANTA FE R. R.



"HANGING BRIDGE" IN THE ROYAL GORGE; COLORADO, DENVER & RIO GRANDE R. R.

Mexico & Southern Pacific Ry. (Atchison, Topeka & Santa Fe R. R.), just east of Lamy, Santa Fe County, N. M. Fig. 1 is a cross-section of the canyon showing the center support of the bridge. It is a deck plate girder structure, crossing the canyon diagonally, the girders being 105 ft. long. The second case is the well known "hanging bridge" in the Royal Gorge, near Canyon City, Colo., on the Denver & Rio Grande R. R., and Fig. 2 shows one of the two "arch" supports of the outer plate girder which carries the ends of the floor beams. The inner ends are carried partly by a short plate girder and partly by a bench of the wall of the canyon. No details of construction are given in either case, and it seems rather late for the society to be publishing a mere general description of the Royal Gorge bridge, which was built some 15 or more years ago, if we remember correctly. We may also state that the cuts reproduced herewith from the paper as published by the Am. Soc. C. E. have been entirely redrawn, as their style of execution was so bad as to be inadmissible in these columns. We know of no reason why the American Society of Civil Engineers should not be at least as particular as this journal in regard to the artistic execution of its engravings, but a very brief examination will show that it is not, a large proportion of its engravings being very poorly done.

THE PENDING BRAKE AND COUPLER LAW.

The Railway Safety Appliances Bill, which was reported favorably from the House committee on Interstate Commerce on June 27, contains the following provisions:

Power driving-wheel brakes must be applied to every new locomotive after July 1, 1893, and all locomotives must be equipped by July 1, 1895, with "a power driving-wheel brake arranged to be operated in connection with the train brake system."

"Train-brake apparatus of such a nature that the brakes can be set and released from the locomotive, with brakes for each wheel," must be applied to new cars built and old cars sent to shop for general repairs after the passage of the act; and after July 1, 1895, the running of such new cars or rebuilt cars not thus equipped is unlawful. After July 1, 1898, the running of any car in interstate freight traffic not equipped with such brakes will be unlawful.

Automatic couplers of the standard fixed as provided below will be necessary after July 1, 1895, for the lawful use of "any new car or any old car that has been to the shop for general repairs to one or both of its drawbars;" and after July 1, 1898, they will be necessary for the lawful movement of any car in interstate freight traffic.

The standard type of automatic coupler is to be chosen by a vote by cars of the railway companies. Before July 1, 1893, every railway company shall file with the Interstate Commerce Commission a statement "setting forth such details with reference to the height, form, size and mechanism of freight-car couplers as it deems essential in order to insure requisite uniformity, requisite automatic action, and requisite safety in service." If the Interstate Commerce Commission finds that companies owning at least 75% of the freight cars represented have agreed on such details as will insure requisite uniformity, automatic action and safety in service, it shall declare that couplers complying with these details shall be the lawful standard. If, however, the companies fail to agree, it is made the duty of the Interstate Commission to select some automatic coupler as a "standard type."

A standard height of drawbar for freight cars and a maximum variation between the drawbars of empty and loaded cars is to be reported to the Interstate Commerce Commission by the American Railway Association within 90 days from the passage of the act, and thereafter all cars built or repaired must conform to this standard. After July 1, 1893, the use of cars which do not comply with this standard is prohibited.

Further provisions are that a car not equipped with brakes and couplers as above provided may be refused in interchange after July 1, 1898; and the carrier loading or starting such a car shall be liable for any damages it may cause. Employees injured by any locomotive, car or train in use contrary to the provisions of the act are not to be held guilty of contributory negligence. Handholds in the ends and sides of the car are necessary to its lawful use after July 1, 1893. A penalty of $100 is fixed for each violation of any provision of the act.

A tee rail with varying width of flange, known as Fletcher's patent rail, is manufactured by the Lowca Engineering Co., of Whitehaven, England. The rail is claimed to possess the great advantage of a wider bearing upon the tie, thus not only having great steadiness, but more room for the spikes, while the extra width compensates for the reduction of area by the spike holes in the flange. When laid upon metal ties with key or wedge fastenings, the keys are clear of the flange of the rail and thus more easily driven. The flange may be widened on one or both sides. The varying width of the base was included in the original design of the T-rail, as invented by Col. R. L. Stevens in 1830 (Eng. News, Nov. 2, 1889), but was given up on account of difficulty in rolling. This difficulty has been overcome in the Fletcher rail. A patent has also been granted in this country recently to Mr. E. G. Patterson, of Titusville, Pa., for a rail rolled with corrugated or notched edges, the spikes being driven in the notches to prevent creeping of the rail.

PERSONALS.

Mr. T. J. Nicholl has opened an office as Consulting Civil Engineer in the Royal Insurance Building, Chicago.

Mr. G. S. Chapin, formerly Assistant Engineer on the sewers at Rochester, N. Y., has been appointed Superintendent of Sewers at that place.

Mr. J. W. Schaub, M. Am. C. E., has resigned his position as Engineer of the Detroit Bridge & Iron Works, Detroit, Mich., to take effect July 1.

Mr. D. B. Robinson, formerly General Manager of the Atlantic & Pacific R. R., has been elected President of the San Antonio & Aransas Pass Ry., vice Mr. Uriah Lott, resigned.

Mr. C. H. Platt, who has been General Manager of the Harlem R. R. since 1880, has been appointed General Superintendent of the New York, New Haven & Hartford R. R.

Mr. Hugh R. Irvine, Superintendent of Tracks and Bridges and Buildings of the Gulf, Colorado & Santa Fe Ry., with headquarters at Galveston, Tex., has resigned his position.

Mr. Joseph H. Franklin has been appointed General Manager of the Grand Central Station in New York, vice Mr. C. H. Platt. His jurisdiction extends over the five miles of approved tracks, as far as the Mott Haven junction.

Col. William Ludlow, of the U. S. Engineer Corps, has been relieved from duty as Engineer of the Ninth and Eleventh Lighthouse Districts, with headquarters at Detroit, and Colonel O. M. Poe has been placed in temporary charge of the service.

Mr. D. McNab has been appointed Superintendent of the Chicago Division of the Chicago, St. Paul & Kansas City Ry., vice Mr. J. D. Farrell, resigned, and Mr. J. D. Tonby has been appointed Superintendent of Terminals, with office at St. Paul, Minn.

NEW PUBLICATIONS.

ECONOMIES IN MAINTENANCE OF WAY.—By Benj. Reece, M. Am. Soc. C. E. Read at the N. Y. Railroad Club, March 17, 1892. The Q. & C. Co., Phenix Building, Chicago, Ill. 12 mo., pamph., pp. 34.

This excellent and readable little paper on track makes a strong plea in favor of tie-plates, and has been neatly reprinted by the Q. & C. Co., as a modest and effective advertisement. Copies will be sent by them on request.

NEW JERSEY STATE BOARD OF HEALTH.—Report for 1890-91. E. M. Hunt, M. D., Secretary. Pamph., 8vo., pp. 489; illustrations and tables.

The report of the Secretary occupies the first few pages of this volume and reviews the various influences affecting the health of the state. Maj. A. A. Woodhull, U. S. A., furnishes a brief report of the Seventh International Congress of Hygiene and Demography. Several papers read before the New Jersey Sanitary Association are printed in full or in abstract. One of these papers was by Secretary E. M. Hunt, M. D., on "Traps and Vents in Sewers or Soil Pipes and Their Uses." This paper is illustrated.

The volume closes with the report of the Bureau of Vital Statistics, which is very complete and includes many tables, and some other matter, under the heading, "Climatology."

The total number of deaths in New Jersey from all causes for the year ending June 30, 1891, was 28,840, or 19.5 per 1,000. Of these deaths 696, or 2.4%, were

from typhoid fever, and 10,181, or about 35% were from the "chief preventable diseases."

TRADE PUBLICATIONS.

MATHEMATICAL INSTRUMENTS AND DRAWING MATERIALS.—Frost & Adams, Boston, Mass. 8vo., pp. 76; illustrated.

This is a special catalogue for engineers and draftsmen. The first pages are worthy of remark. They contain a price list of fine German instruments, illustrated with over a hundred figures finely engraved, full size, on steel.

PETROLEUM ENGINES.—Priestman & Co., Philadelphia, Pa.; 8vo., pp. 15.

This plant deals with the Priestman petroleum engine (Eng. News, Nov. 17, 1888), which is operated by the combustion of small quantities of stomiged kerosene in the cylinder. Particulars are given of the use of these engines for different purposes, with particulars of oil consumption and cost of operating.

LOCOMOTIVES AND STATIONARY ENGINES.—Lowca Engineering Co., Whitehaven, England. 4-to., pp. 93.

This is an illustrated list of contractors,' tank and light locomotives, with specifications and tables of tractive force, etc. The company also manufactures stationary engines, water cranes, boilers, grip cars for rope haulage, slag cars, rock drills, and other hauling and mining plant. The book also contains cuts of the Fletcher tee rail having the width of base increased at the ties, as in Col. R. L. Stevens' original tee rail (Eng. News, Nov. 2, 1889).

STEAM ENGINES AND BOILERS.—Watertown Steam Engine Co,, Watertown, N. Y.; 8vo., pp. 32. Illustrated.

This is an illustrated catalogue of engines and boilers of different kinds, with descriptions, dimensions, etc. On its "Automatic" engine the company uses a three-ported D valve, with a cut-off valve on the back of the main valve, driven by a separate eccentric. This cut-off valve can be regulated by revolving the valve stem, which by means of a rack and pinion moves the valve sideways across the main valve, and increases or decreases the diagonal openings in the main valve. Portable and agricultural engines are also made.

ENGINEERS' HANDBOOK OF STANDARD WOOD-WORKING MACHINERY.—The John A. White Co., Dover, N. H., 16mo., pp. 48.

WIRE ROPE AND KINDRED PRODUCTS.—The John A. Roebling's Sons Co., Trenton, N. J.; 16mo., pp. 56.

TESTING MACHINES, SCREW JACKS AND TRUCKS.—Riehle Bros. Testing Machine Co., Philadelphia; 16mo., pp. 52.

These three little pamphlets are all of the "multum in parvo" order. They are quite complete on their subjects. Riehle Bros.' schedule rates for tests, given in an accompanying circular, may have interest.

Tests requiring machine for	50,000 lbs.	120,000 lbs.
Test No.		
1 Tensile Strain, plain test	$0.75	$1.00
3 do with elastic limit and elongation	1.00	1.50
4 do do and per cent. reduction	1.50	2.00
5 Transverse Strain (plain test)	1.00	1.50
6 do full test, with record.	1.50	2.00
7 Compression Test (plain test)	1.00	1.50
8 do full test, with record	1.50	2.00

SOCIETY PROCEEDINGS.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—The regular meeting was held June 14. The discussion of the evening was on the annual address of the retiring president, Mr. Gobeille, on "The Financial Status of the Engineer." Chas. S. Howe, Secy.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on June 18, a paper on the Improvement of the Mississippi River was read by Capt. Smith S. Leach. A section of the first rail used by the Camden & Amboy R. R., laid at Bordentown, N. J., in 1831, was presented to the club by Mr. Rufus Hill.

ENGINEERS' CLUB OF PHILADELPHIA.—Meeting of June 18, President Christie in the chair; 29 members and visitors present.

The minutes of the last meeting were amended by crediting Mr. Henry G. Morris with the suggestion to improve and use the infected district of South Sixth St. as a site for the new mint, and by substituting the word "energy" for "power," in Mr. Loss' discussion on Shearing of Iron and Steel, so as to read, "it requires more energy to cut iron than steel of the same dimensions."

Upon motion of Mr. John C. Trautwine, Jr., the club appointed Mr. Jos. M. Wilson to aid the Committee of the Am. Soc. C. E., by the suggestion of suitable persons to furnish papers for the meeting of the World's Congress Auxiliary of the Chicago Exposition.

A paper by Capt. Smith S. Leach, on the Improvement of the Mississippi River, was presented and read by the Secretary. Mr. Trautwine explained that this paper was written by request, to more fully explain the method of fixing the banks and confining the floods of this river, which had been illustrated by a series of photographs presented some time since by one of the members of the club.

A communication from Mr. Robert L. Holliday, describing a stone box culvert, built in 1832, south of Newcastle, upon the Delaware Division of the P. W. & B. R. R., was read, and a sample of 2-in. white plank, which formed part of its foundation and had been under water for 60 years, was exhibited in connection therewith. The wood showed an excellent state of preservation, and excited much interest. A section of the first rail used by the Camden & Amboy R. R. was presented by Mr. Rufus Hill. It is believed to be from the first lot of rails made in this country, and was laid in Nov. 12, 1831, at Bordentown, N. J. Designed by Mr. R. L. Stevens.

L. F. Rondinella, Secy.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—We give elsewhere in this issue the remainder of the interesting discussion on compound locomotives, which was really the main feature of the convention and have commented upon it editorially. At the close of this discussion, on Tuesday, the report of the Committee on "The Present Status of the Car Coupling Question," was presented by Mr. M. N. Forney. The report recommended merely a formal approval of the action of the M. C. B. Association, but after some discussion it was concluded to be best not to interfere in any way until the M. C. B. Association had completed its work now in progress on coupler standards.

TESTS OF STEEL AND IRON.

The appointment of this committee resulted, we believe, from a discussion upon the effects of working steel at a blue heat. Naturally, therefore, the committee turned their attention to this point first. Samples of steel of various thicknesses and brands were heated to a temperature of 500° to 800° and bent under the hammer. The tests showed such variable results that little new information is to be gained from them. Steel from a firebox which cracked badly and was removed after only ten months' service gave, in some cases, very good results in the bending tests, both at a blue heat and cold. The committee was forced to conclude that steel which stands a blue heat bending test is not thereby proved a good material for fireboxes. In corroboration of this, some steel from the condemned firebox, above referred to, stood the blue heat bending test better than new steel of the same brand.

On account of the tradition that iron plates are less liable to crack in the firebox, the committee made experiments with the best iron boiler plates, both American and English. The result was that at a blue heat the tendency of the iron plates to crack was decidedly greater than was the case with steel.

An examination was made of several samples of old steel by etching the edge of the plates. In several cases the central portion of the sheet for about one-third its thickness showed a spongy texture, and appeared to be coarser in grain than the outer layers. This central layer was carefully removed by a narrow tool and the inner layer of the sheet at once sprung inward toward the fire, the deflection being about 1-16 in. in 8 ins. The water side of the sheet remained almost perfectly straight. After experimenting to ascertain whether this springing was caused by the action of the tool, the committee concluded that there was a permanent expansion of the sheet on the side next to the fire.

On the relative merits of steel and iron tubes, the committee reported that on Dec. 20, 1890, a locomotive was equipped with 114 iron tubes and 113 steel tubes. On March 9, 1892, when all the flues were removed, 17 of the iron tubes and 64 of the steel tubes were condemned on account of pitting and corrosion. The committee was also advised that steel tubes in a large number of other cases have shown a lack of durability in service.

An experiment was made on a stationary vertical boiler to determine the temperature of the inner firebox sheet. The difference in temperature indicated was about 25°, but it is doubtful whether the measurement of the higher temperature was anywhere near correct.

On the hypothesis that staybolts fail from bending and vibration, an apparatus was devised to bend a staybolt back and forth and at the same time keep it under tensile strain. Steel and iron both were tested in this apparatus, and the steel bolts gave much the best results. As steel staybolts in service have shown very poor results, the committee "did not think that they had added anything to the subject of a proper method of determining the suitability of any special material for staybolts."

William Smith, J. N. Barr, A. W. Quackenbush, P. H. Peck, D. L. Barnes, Committee.

This report started a very interesting discussion on firebox steel. Mr. Wm. Smith, Supt. of Motive Power, Chicago & Northwestern, showed samples of steel from a firebox which had been in service since 1873 and had made 600,000 miles, also samples from one which had been condemned with only 50,000 miles to its credit; both samples showed excellent chemical analysis; and he expressed his opinion that chemical analysis wasn't worth the paper it was written on as an index of the quality of steel. Mr. Wellman, of the Wellman Steel Co., and Dr. Huston, of the Lukens Iron & Steel Co., explained that chemical analyses were a necessity to the manufacturer, but he would not think of relying on them alone. Dr. Huston further said that the cause of the failure of the poor specimen submitted by Mr. Smith was piping in the ingot from which the steel was rolled. The best way to discover this piping yet devised is to make a nicked bending test, as practiced by the Pennsylvania R. R. Some recent specifications require a guarantee from the steel maker of two years. If steel runs that length of time without cracking, it's not likely to crack. Mr. Gibbs suggested that the committee investigate the difference between steel of granular and silky fracture, the two showing the same physical and chemical characteristics and yet having noticeably different internal structure.

Mr. Chas. Blackwell and Dr. Huston called attention to the great care necessary in cutting test coupons from boiler plate. If shears are used, the sheared edge should always be planed off. The shorter the section pulled, the higher the tensile strength. A piece 2 ins. between shoulders will show 2,000 lbs. per sq. in. more strength than one 8 ins. long, and the standard for steamboat boiler inspection will increase the apparent tensile strength 8,000 lbs.

The discussion here turned on the question whether there had been a deterioration in the quality of steel on account of sharp competition forcing down the price. It was generally agreed that high quality was of much more importance in firebox steel than low price. Secretary Sinclair reminded the members that this was an old subject and one which years ago, gave the members very much trouble. Of late years, however, better brands of steel had overcome the trouble, and railway officials had grown careless and thought anything would do for fireboxes. But as the steel began to get cheaper it began to get bad. On motion, the report of the committee was received, and the committee continued.

At the noon hour discussion on topics suggested by the members the question was asked whether there was any good reason for departing from the standard form of tread adopted by the Association. It was stated that many of the principal railways order tires varying slightly from the standard, and tire-makers have to keep a large variety of rolls to satisfy their customers. They are also prevented from working on stock in dull times, as they might safely do if the standard was rigidly adhered to. There was little discussion on this question, however, and no action was taken upon it.

UNIFORM LOCOMOTIVE PERFORMANCE.

The Committee on Uniform Locomotive Performance Sheets reported as follows:

Mileage.—Passenger and freight mileage should represent actual miles run, with 5% added to freight mileage. Engines in construction or snow-plow service should be credited with 10 miles per hour; switching service, 8 miles per hour. No extra mileage should be allowed for going to and from the roundhouse, and an engine assigned to more than one class of service should have proper credit for each class.

Fuel.—1 cord of wood should be rated equal to 1 ton of coal, and 2,000 lbs. should be considered a ton in all coal weights. All expense of handling fuel to be included in its cost.

Oils.—Charge to engine the illuminating oils used in lamps, headlight and torches belonging to it only. Charge to repairs the lubricating oil used about engine while undergoing repairs and in packing journal-boxes while in the shop. Charge lubricating, illuminating and valve oil separately.

Repairs.—Charge to repairs the waste used on locomotive while undergoing repairs and labor of such mechanics, helpers and others as actually work on repairs. All labor about roundhouse or turn-table not on repairs should be charged to locomotive service. Engine repairs caused by accidents other than engine failures should not be shown on performance sheet, but should be kept separately and charged to the department responsible for the accident. New engines purchased or built to replace others worn out should not be charged to repairs, but all repairs of existing locomotives should be so charged except the application of new devices, such as airbrake equipment, smoke consumers, extension front end, etc. These should be charged to new equipment or betterments. Tools issued for use on engines should be charged to repairs.

Loads.—In figuring loads, for cars 30 ft. long or over, three empties to be considered equal to two loads, except for gondola and flat cars, where two empties shall be considered equal to one load.

Geo. F. Wilson, J. S. McCrum, John Player, Jas. McNaughton, Jno. A. Hill, Committee.

The clause of this report requiring repairs to loco-

motives due to accidents not caused by the engine to be charged against the department causing the accident, was criticised by several. On motion, the committee was continued for another year, with instructions to report further a uniform blank for an "exchange" performance sheet, on which the average monthly results in each class of service should be recapitulated. The convention then adjourned till the following day. In the afternoon most of the members visited the Schenectady Locomotive works.

STANDARD BOLTS AND NUTS.

The Master Mechanics' Association formally adopted the United States or Sellers standard for bolts, nuts and screw threads at its fifth annual convention. The committee's report, therefore, was chiefly intended to urge the importance of a more rigorous observance of this standard. A considerable number of Master Mechanics and Master Car Builders seemed to have the impression at the time the standard was adopted that it referred merely to the number of threads per inch, whereas it is of equal importance that the threads should be of the form and proportions laid down, and that the diameters of the screws should conform to the sizes specified. The standard diameters in the Sellers system vary 1-16 in. between ¼ in. and ⅝ in., and by ⅛ in. between ⅝ in. and 1¼ in. There are no other sizes except those larger than 1¼ in., hence a bolt 13-32 or 21-32 in. diameter does not conform to the Sellers standard, uniformity in size being essential to interchangeability. It is sometimes claimed that the Sellers standard cannot be maintained in use; but in fact the form of the thread makes it very easy to duplicate it to gage size. By making the outside diameter of the tap slightly larger (though not larger than the angle of the thread) the life of the tap before it wears below gage size is greatly lengthened. The corners may wear slightly, but the wear is unimportant if the taps are properly used. To insure the maintenance of the standard, shops should be provided with a plug and cylinder gage and an internal and external standard thread gage by which taps and dies can be tested; and caliper gages for shop use can be made and maintained with accuracy.

Some questions having arisen as to the relative sizes of rough and finished nuts; the committee, at the suggestion of Mr. Geo. M. Bond, of the Pratt & Whitney Co., proposed that the U. S. standard for rough nuts be adopted regardless of finished sizes. Finished sizes should then be made of the same size, being forged enough larger to allow for finishing.

For taper-fitted bolts, the committee recommended a standard taper of 1-16 in. per ft., and advised the use of a taper bolt in preference to a straight one, where accurate fitting is necessary. An ordinary straight fluted reamer is made smaller every time it is ground, but in a taper reamer this defect is overcome by allowing the reamer to enter the hole a little further, as it becomes reduced in size. These reamers are guarded at their upper end by a collar driven on and covering the entire unused part of the reamer. The collar can be dressed off from time to time to gage at its lower end to keep its size correct.

Wm. Swanston, Wm. Garstang, T. W. Gentry, W. Lavery, A. Dolbeer, L. R. Pomeroy, Committee.

In the discussion on this report the interesting fact was brought out that a lot of round iron which had been rejected by the Pennsylvania R. R. inspectors, on account of being over-sized, had been purchased and used by contract car builders. As a result many railroad shops are ordering taps 1-16 in. larger than standard sizes to make nuts for these odd-sized bolts in repairs. On the other hand the representative of the Madison Car Works said that recently, where specifications called for U. S. standard bolts and nuts, samples of bolts and nuts were submitted by three different railway companies for the builders to follow. The samples were over-size by 1-16 in., and the inspectors required the nuts and bolts to be over-size to correspond to the samples, thus disregarding the U. S. standard, which was distinctly specified. The following resolutions were finally adopted:

1. That this Association commends and emphasizes the U. S. standard and urges upon all a rigid adherence to the same, and deprecates the use of more than one set of dimensions for each size of bolt and nut, and urges all railroad officers to discontinue the use of screws which are not of standard sizes.
2. That it is practicable to maintain the U. S. standard with the method and gages available.
3. That this Association adopts the U. S. standard for nuts based on rough size regardless of finished size.
4. That the committee be instructed to prepare a circular calling attention to the importance of maintaining the standards of screw threads, and that the Secretary send copies of this circular to all members, general superintendents, general managers and railroad newspapers.

BOILERS FOR HIGH PRESSURE LOCOMOTIVES.

The report of this committee consisted chiefly of letters detailing the experience of several of those who have been prominent in the use of higher boiler pressures, with prints showing the construction of high pressure boilers, by some of the leading railways and locomotive builders. We shall review these more fully later. The bulk of opinion rather favors the Belpaire boiler over the radial stay, although either is almost universally preferred to the crown-bar boiler for high pressures. We quote from the committee's summary as follows:

Your committee was somewhat at a loss to know what constituted high pressure on a locomotive boiler. It is not long since 150 lbs. was considered high. This has become common. We therefore concluded to call anything in excess of 150 lbs. high pressure. Your committee has not obtained much information as to the action of these boilers in service, because it is of a comparatively recent date that such high pressures have been used, and most of the boilers being so new they probably have not given much trouble. We are under the impression that trouble will develop with broken staybolts at top of firebox in all types of boilers. This trouble can be mitigated by increasing the length of staybolts at that part of the boiler by reducing width of firebox at top. Some of the tubes would have to be left out, but this would be offset by increased life of staybolts and freer steaming. The reduction of transverse strains in staybolts, obtained by increasing their length, is much greater than generally supposed. The reduction of width of water space, consequently length of staybolts at top of firebox, is exceedingly bad practice. The double riveting and increased size of mud ring to resist the downward pressure of firebox is important on all high-pressure boilers. The radial-stayed boiler is coming into more general use and has been found to be a strong, reliable boiler. The objection urged against the angles of the stays and difficulty of keeping them tight has not been found valid in practice. If the holes are threaded in outside sheet with a short tap, then threaded in crown sheet (instead of both holes at same time with one long tap), and the stays enlarged at points where they fit in sheets, and thread cut on there, there will be the same thread, but from different starting points, and trouble will be had from leaking and loose stays.

Your committee have knowledge of 50 radial-stayed boilers, with stays riveted over outside and inside, that in seven years had not had a broken stay on the crown-sheet or trouble from sediment collecting. Staybolts have broken on side-sheets, but not more than on boilers with crown-bars on fireboxes. It looks as though the radial-stayed and Belpaire type were the coming boilers. The Belpaire is not so well known as the other, but its merits will soon be understood and appreciated. The Belpaire boiler costs about $150 more to manufacture than the ordinary boiler. The objections to the boiler, with crown-bars and sling-stays for high pressure, have been fully described. The butt-joint has been generally accepted as the best, though the covering-plates make a resistance to the boiler retaining true circular shape in expansion. The ideal boiler is one without joints, but as we cannot have that we should have as few joints as possible. Waist or cylinder-part of boiler should always be made in one sheet. Outside shell of firebox could also be one, and when radial stays are used inside sheet could be a single one.

Jas. M. Boon, H. D. Gordon, J. S. Graham, J. H. McConnell, Committee.

The discussion on this report served to emphasize strongly the correctness of the committee's conclusions, especially as to the advantages of radial stay and Belpaire boilers over the old crown-bar type. Mr. Vauclain, of the Baldwin Locomotive Works, said that at present hardly 10% of the locomotives built by them were equipped with crown-bar boilers. The chief interest in this discussion turned on the subject of staybolts, for it was generally acknowledged that breaking of staybolts was the chief thing to be guarded against in designing high-pressure boilers. The remedy proposed by the committee of enlarging the water space at the top of the firebox to increase the length of the staybolts, was universally commended. Among other points of interest brought out was the likelihood of cutting incorrect threads in tapping for the long staybolts in Belpaire and radial-stay boilers. The expansion of a long tap by the heat from cutting the thread in the roof sheet might cause it to cut a thread from a different starting point in the crown sheet. Mr. Chas. Blackwell inquired whether anyone was using the Whitworth thread; as that has a rounded top and bottom, bolts cut with it might have longer life than with a thread of the ordinary pattern. Mr. Pulaski Leeds said that in building radial-stay boilers he used a headed bolt. The nuts on the crown-sheet are made at least 1½ times as thick as the diameter of the bolt; thus a fine thread can be cut, which will not weaken the bolt so much as a coarse one. He practiced turning down the bolt between the sheets, thus distributing the bending over the length of the bolt instead of concentrating it at the sheet. He cut the threads in a bolt cutter in preference to a lathe. Mr. C. E. Smart suggested swedging the bolts flat between the sheets instead of turning them down; this would permit the bolt to bend back and forth without overstraining the metal. He intended to try it as he had had much trouble with broken staybolts in the top row. Mr. Lauder approved the committee's recommendations, especially with regard to reducing the number of seams in a boiler to a minimum. He had little difficulty with staybolts, but he thought this was chiefly due to the use of good water. He used 1-in. staybolts and paid 6½ cts. per lb. for staybolt iron.

Mr. Vauclain said that he was surprised to hear that the turning down of staybolts between the plates was not always practiced. The Baldwin Works have turned down all staybolts for years except in places where they were never known to break. When one boy can run a machine which will cut eight staybolts at one time there is no need of neglecting this on account of expense. He heard many advocating the softest iron in the market as the best for staybolts. He believed in an iron as hard as was consistent with heading the bolt nicely. The higher the tensile strength of the iron, the more vibrations it will stand, for it is not so easily strained beyond the yield-point. The Baldwin specifications for staybolt iron call for a tensile strength of 50,000 to 52,000 lbs. per sq. in., the upper figure being preferred, and the lower being insisted upon as the minimum. The size of staybolts and thickness of sheets should not be fixed by any arbitrary rule, but should be proportioned to the strains to be sustained. The practice of the Baldwin Locomotive Works is to proportion all parts of the boiler with a factor of safety of five.

The discussion then turned to the Wootten boiler, and some of the members repeated the current impression that the Wootten boiler is a dangerous type. Mr. Vauclain replied to this that as the Baldwin Locomotive Works had built more Wootten boilers than all other shops combined, and had kept careful watch of the matter, he was able to say emphatically that the Wootten boiler was not more liable to failure than boilers of other types. As a number of locomotive boilers have exploded recently on the Philadelphia & Reading, and as that road is known to have a great many Wootten boilers, the impression has got abroad that the Wootten boiler was responsible for these explosions. As a matter of fact, only two of the recent explosions were of Wootten boilers, and those explosions occurred on account of low water. The other boilers which failed were of the crown-bar type, and he was afraid that the cause of their failure was weakness. The Baldwin Locomotive Works build Wootten boilers to carry pressures as high as 200 lbs., and consider them perfectly safe. Mr. A. E. Mitchell said that there were 75 Wootten boilers on the New York, Lake Erie & Western and there had been only one case of failure; a crown-sheet came down on account of low water. The Wootten boilers are more troublesome to keep in repair than other boilers.

The report of the joint committee on Air Brake and Signal Instructions was then presented, and was the same as was submitted to the M. C. B. Association. It was voted to adopt the book of instructions for use during the coming year.

The committee on subjects for investigation by committees during the coming year reported the following list in addition to the subjects continued from the present convention:

1. Standard diameters for wheel centers and tires, for both larger and smaller sizes than those now adopted.
2. Boiler attachments and means for increasing their safety and lessening the number of holes in boilers.
3. Utility and cost of malleable castings.
4. Attachment between engine and tender, to increase safety and prevent tender mounting foot-board.
5. Foot steps and hand rails.
6. Best means of preventing the smoke nuisance, when using soft coal in cities.

The Committee on Resolutions presented its report as did also the Committee on Delegates to the Superintendents' Association's Meeting. Messrs. John Mackenzie and J. N. Lauder were elected delegates. For the next place of meeting a rising vote showed 46 to be in favor of Waukesha, Wis. The concluding business was the election of officers, which resulted as follows: President, John Hickey; Vice-Presidents, Wm. Garstang, R. C. Blackall; treasurer, O. Stewart; Secretary, Angus Sinclair. The convention then adjourned.

COMING TECHNICAL MEETINGS.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
July 1. Secy., E. K. Smoot, 903 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
July 1. Secy., O. von Geldern, 319 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
July 2. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
July 2. Union Station, St. Paul.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
July 4, 5. At Richmond. Secy., J. E. Schick, Roanoke, Va.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
July 7. Secy., T. G. Philfeldt, 119 Adams St.
WISCONSIN POLYTECHNIC SOCIETY.
July 11. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
July 11. Secy., C. L. Annan.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
July 14. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
July 14. Secy., O. H. Landreth, Nashville, Tenn.
MONTANA SOCIETY OF CIVIL ENGINEERS.
July 16. Secy., F. D. Jones, Helena.
ENGINEERS' CLUB OF CINCINNATI.
July 21. Secy., J. P. Wilson.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Aug. 18. At Atlanta, Ga. Secy., P. A. Charpiot, Macon, Ga.
ENGINEERS' CLUB OF PHILADELPHIA.
Sept. 3. 1122 Girard St. Secy., L. F. Rondinella.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 7. Secy., F. Collingwood, 127 East 23d St., New York
WESTERN RAILWAY CLUB.
Sept. 20. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Sept. 20. Secy., E. N. Clark, Pittsburg, Pa.
ENGINEERS' CLUB OF ST. LOUIS.
Sept. 21. Secy., Arthur Thacher, Odd Fellows' Building.
CENTRAL RAILWAY CLUB OF BUFFALO.
Sept 28. Secy., Jas. Macbeth.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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VOL. XXVII. THURSDAY, JUNE 30, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The driving of Chicago's four-mile tunnel was completed last week, but almost on the same day came a heavy rain and wind, causing the Chicago River to discharge a 3-mile per hour current into the lake, and sweeping with it thousands of cubic feet of sewage. In our issue of May 12 there appeared an account and editorial discussion of a similar flood and pollution of the water supply. Many of the Chicago papers and some of the city officials strenuously maintained that the May flood of sewage did not reach the two-mile water-works intake crib, but last week it was generally admitted that the water at this crib was polluted. In addition, it is also admitted that the sewage last week reached within a half-mile of the new four-mile intake, upon which hopes have long been founded for a supply beyond chances of contamination. But if the sewage at times pollutes the water two miles from the shore, what folly it is to expect that it will not reach the four-mile point! Because the visibly dirty mass of water had not, so far as observed, extended to the farther point it seems to have been held that there was no danger of pollution there. It begins to look as if Chicago will soon see that it must either exclude all sewage from the lake, purify it or the water supply, or else establish an intake many miles to the north, with an aqueduct to bring the water to the city. The Chicago "Inter-Ocean" repeats some figures in this connection which we give below, adding a column for the deaths per 1,000,000 inhabitants, that the meaning of the figures may be more clearly seen. We gave a much more extensive assortment of the same figures in our issue of April 21, but they will bear some repetition. It will be remembered that the tendency to defilement is increasing all the time by growth of the city in sections where the natural drainage is into the lake.

Cities:	Population.	Deaths from typhoid. Total.	Per 1,000,000
Chicago, 1890	1,100,000	1,008	1,008
" 1891	1,100,000	1,997	1,815
" 1892 (so far)	1,200,000	1,680	1,400
New York City, 1888	1,536,000	304	....
" 1889	1,583,000	367	237
" 1890	1,631,000	352	216
" 1891	1,700,000	384	226
London, 1890	4,421,000	619	140
Baltimore, 1891	455,000	140	308
Boston, 1891	459,000	154	335
Cincinnati, 1891	300,000	186	620

Unless we are deceived as to present tendencies, the solution of the rapid transit problem on the east side of New York is rapidly reducing itself to the opening of the Grand Central tunnel and the addition of four more tracks above the present tracks to be used for rapid transit purposes. This seems not only the cheapest and most sensible, but the only thing to do. The only other possible route on the west is Madison Ave., where a rapid transit line of any kind would ruin a small tenderloin residence district and yet be going right away from the heaviest traffic. On the east, Third and Second Aves. are already occupied by elevated lines, and Second Ave. is so far east of the center of traffic as to do very little business. On the other hand, Fourth Ave. is already of extra width (130 ft.) and has its values already depreciated because of the partially open tunnel through it. The converting of this tunnel into an open cut with four more tracks for local use near the surface would not depreciate values further, but rather increase them. The tunnel is so far below the surface that trains upon the upper tracks would at no point extend much above the surface, and for much of the distance would be wholly below it. The opening would also do away with the nuisance of bad ventilation which is greatly impeding the development of the "annexed district" of New York and the whole of Westchester County. The traffic on the existing four lines already closely approaches the limit of their capacity, and the development of the district above the Harlem has but yet begun. With this improvement carried through, local trains from points 20 miles above the Harlem could be run through direct to the City Hall, and a new and greater New York would before long grow up above the Harlem. No other solution seems so sensible or so feasible, and, we cannot but feel, no other will find favor.

So far as the necessities of Manhattan Island alone are concerned the same end might be achieved in a measure by permitting two more tracks to be added above or (in the Bowery) alongside of the two tracks now on Third Ave. Without now saying as much for any other of the existing elevated lines, we believe that the public good demands this expansion of the Third Ave. service under proper conditions as to adequate station accommodations, train service, payments to the city, and the like, while no private interests would be likely to suffer more from the four-track line than they have already suffered from the two-track line. We are, therefore, heartily in favor of adding two more tracks to the Third Ave. system. The present crowding on that line is indecent, dangerous to health and destructive of comfort. But no possible expansion of the Third and Second Ave. service will answer the requirements of the district above the Harlem. They will have all they can do, and more, too, to take care of the traffic of Manhattan Island and Morrisania. Not only the suburban district beyond but the general railway traffic must soon have better facilities than now exist. For this district and this traffic there is no visible substitute for a great enlargement of the trackage facilities to and below the Grand Central Station at 42d St. Such enlargement, therefore, must come sooner or later. Why not sooner, and save needless choking of the growth of New York?

The reader who is interested in the higher problems of physics will hardly need to have us call his attention to the article in another column by Prince Kropotkin on electricity as a mode of motion, reprinted from the "Nineteenth Century." It summarizes the results of the latest researches as simply as their nature admits of, and the net result of seemingly conclusive experiments is that with vibrations or wave-lengths in the ether:

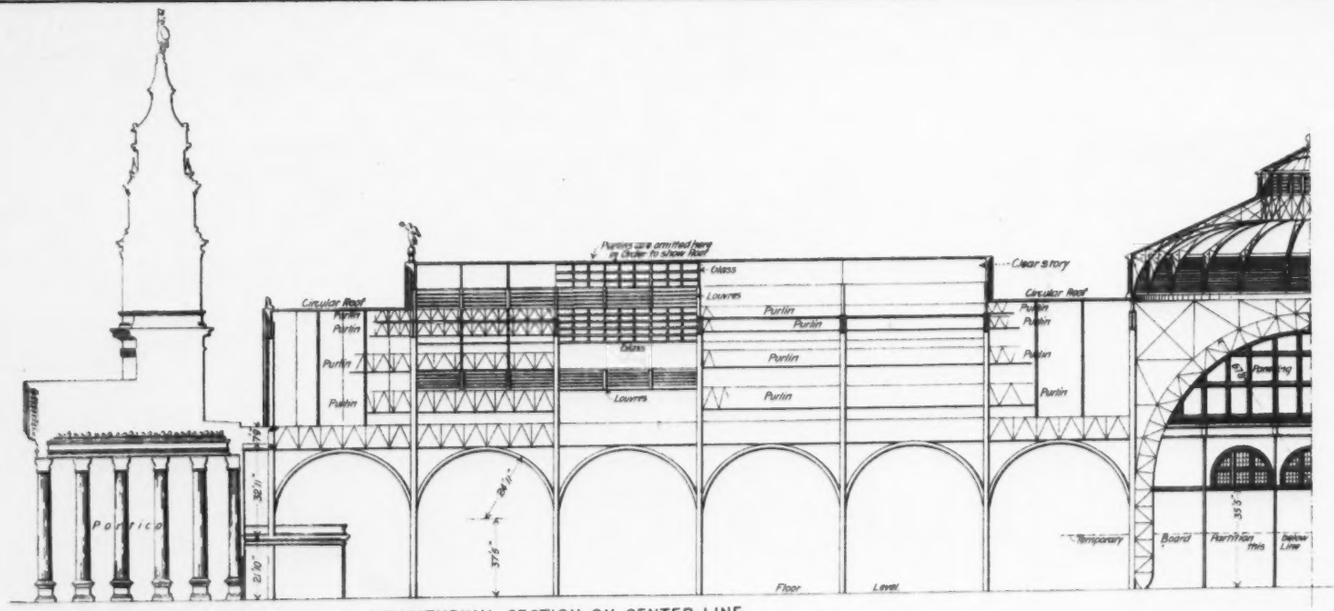
.000,012 to .000,016 in. long, we have...Chemical energy.
.000,016 to .000,030 " " " " ...Light.
..... to .000,120 " " " " ...Radiant heat.
..... to yds. or miles " " " ...Electricity.

If these results may be accepted, we have squarely before us the problem: Given, vibrations of any length in the "ether" (whatever that is), to modify their length at will. The problem of the transformation of energy reduces down to that. When some benefactor of mankind has solved that problem, if it ever is solved, a new era indeed in civilization will open. We may then have electricity from heat, light without heat from electricity or any other form of energy, and divers and sundry other things which we can now only dream of, or perhaps not that. When we consider that pretty much all that is now known of the real nature of electricity, heat and energy is the fruit of the last twenty years (Joule's equivalent and first series of experiments were not announced until 1849), it seems a pretty safe conclusion that science is yet young, and that all which has been yet achieved is but a trifle compared with what is yet to be achieved. Moreover, we know that in the living organism, heat and energy, energy and light, energy and electricity, are transformed into each other by some mysterious process with the greatest ease, and to a large extent according to the will or needs of the organism. It may be that this power is one of the properties of living "protoplasm," and that man will never be able to understand it or to imitate it until he has learned the secret of life itself; but all the recent tendency of science is to indicate that the secret of transforming one form of energy into any other may yet be discovered, and perhaps by very simple means, compared with which our steam engine will seem but a "relic of barbarism."

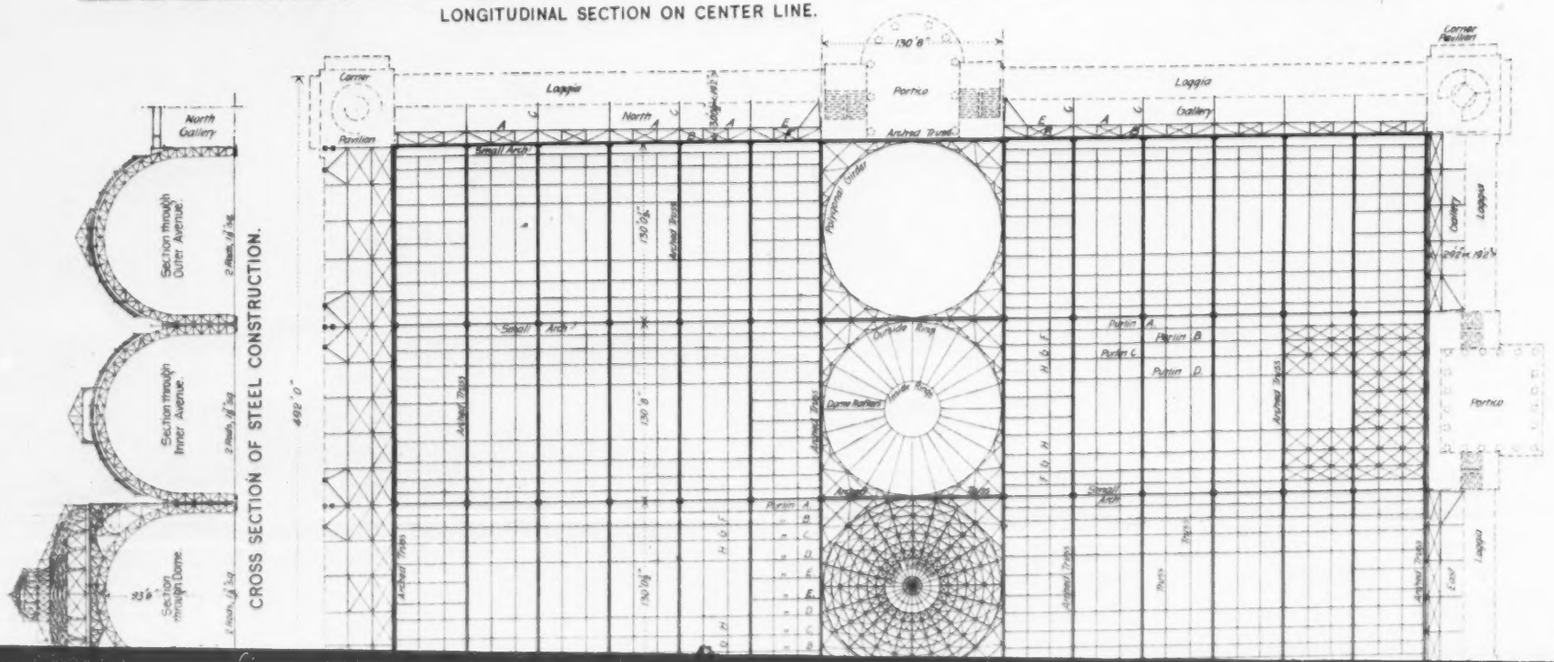
The fact that electricity, like heat, light and radiant chemical energy, is a manifestation of energy, has long been known, but up to the last four or five years scientists have been uncertain as to the manner in which energy existed in the electric current. The old idea of an electric fluid, which is still prevalent outside of scientific circles, served to mislead investigators. At present, however, the researches of such scientists as Hertz, Lodge, Crookes, Sir Wm. Thomson and Tesla seem to have established the fact that electricity, like heat and light, is merely a vibration in the so-called "ether" which is believed to permeate all space. It is notable that all the original theories as to what we now call forms of energy, were materialistic. The Newtonian (corpuscular) theory of light, which was the generally accepted one for half a century, was that light was an effect produced by an incessant fire of infinitesimal but material cannon-balls thrown off in all directions from the light-giving body. Heat was a material something stored in the pores of the visible body. Electricity was a "fluid." All these assumed material substances have been shown to be non-existent, and not necessary to explain the phenomena. But there still remains one grave difficulty with the later theories. The notion of a material ether itself is almost as contrary to what we know of the nature of other matter as the corpuscular theory of light, and almost as much a mere evolution of the scientific inner consciousness, to explain what is otherwise inexplicable. We have not a particle of direct evidence to prove that there is a substance with properties such as we assign to this ether. We have only to eliminate the notion of a material ether, as we have eliminated the notion of material light particles, and we shall be down to hard pan! "I believe because it is impossible," the old monk declared. The modern scientific man, possibly, would do well to reverse this logic and declare: I disbelieve because it is so very convenient a theory, with nothing but its convenience to support it.

There has been so much said and written concerning crystallization or changes in the internal structure of iron and steel when subjected to continuous jarring, vibration or bending stress alternating in opposite directions, that the matter has come to be quite a bugbear to many engineers. It is the general belief that the softer the iron or steel, or the less its percentage of carbon, the less will it be liable to crystallization in service. As a result of this belief the softest grades of iron and steel are very generally specified for use in car-axles, boiler stay bolts and other places where the metal is to be subjected to vibration or to alternate tension and compression. Certainly no fault is to be found with the desire to secure a tough metal for such work, but there is, perhaps, some confusion between the qualities "soft" and "tough." In specifications for steel we guard against hardness or brittleness by specifying that the tensile strength shall not exceed a certain amount; but it is contended by good authorities that where the toughest metal is desired there may be such a thing as having a metal of too small tensile strength.

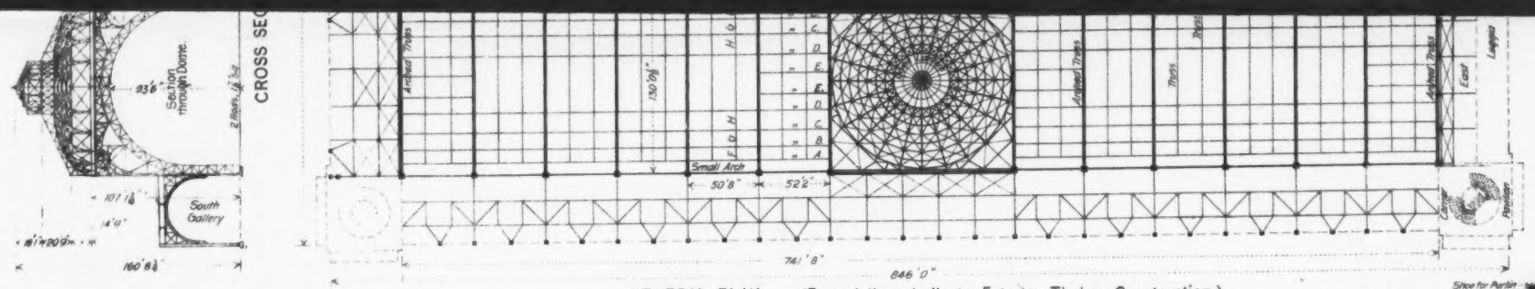
An excellent illustration of this was given in the discussion on stay bolts for locomotive boilers at the recent Master Mechanics' Convention. Mr. S. M. Vauclain, Superintendent of the Baldwin Locomotive Works, stated that instead of using a soft iron for stay bolts he used as hard an iron as would head down satisfactorily. His specifications call for iron of not less than 50,000 lbs. tensile strength, and 52,000 lbs. is preferred. The reason for this is a simple one. Stay bolts break, according to the best authorities, from being bent alternately back



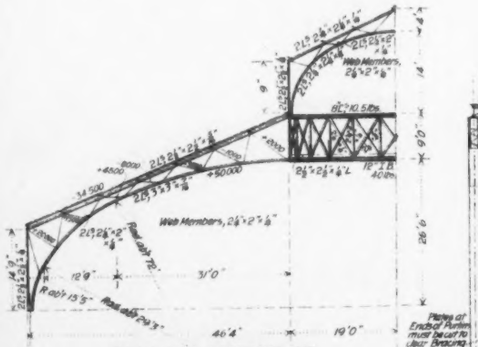
LONGITUDINAL SECTION ON CENTER LINE.



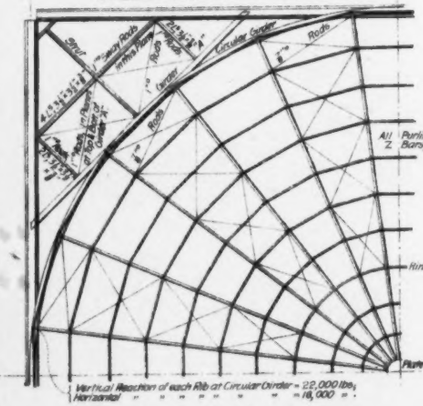
CROSS SECTION OF STEEL CONSTRUCTION.

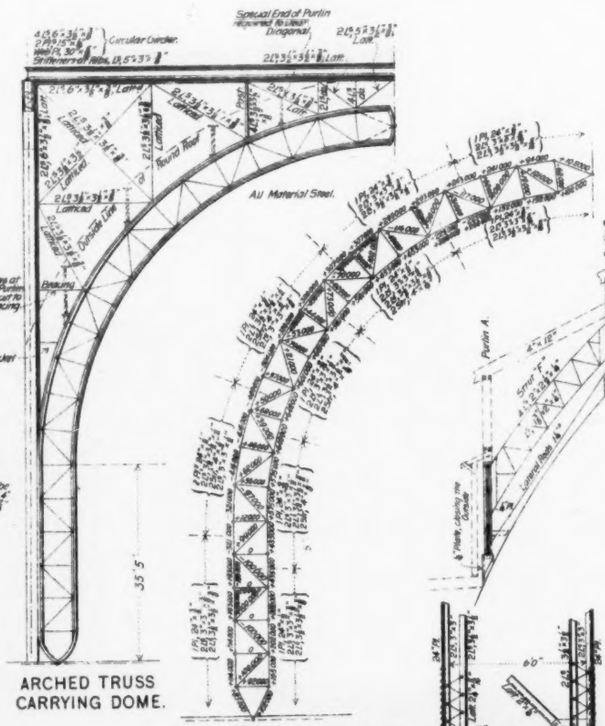


GENERAL PLAN. (Dotted lines indicate Exterior Timber Construction.)



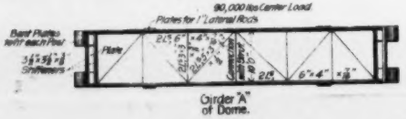
PLAN AND SECTION OF STEEL FRAMING OF DOME.



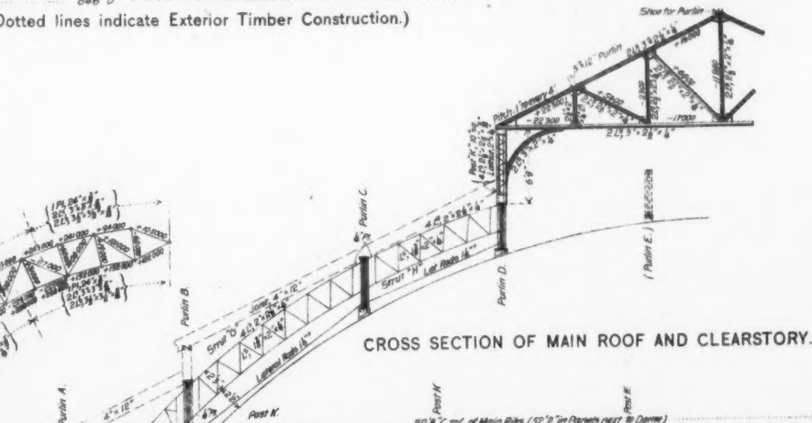


ARCHED TRUSS CARRYING DOME.

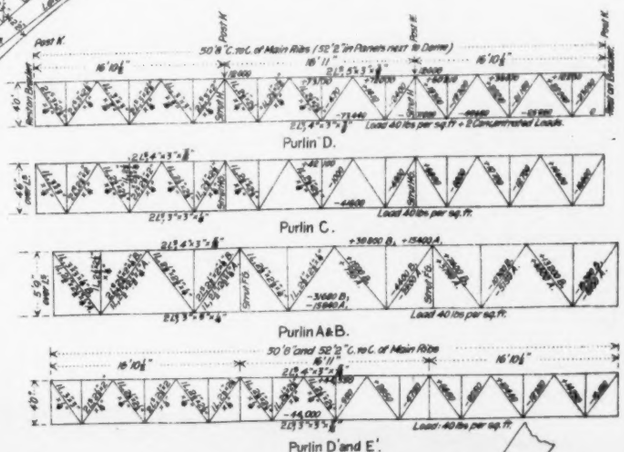
STRAIN SHEET AND MAKE-UP OF MAIN ARCHED TRUSSES.

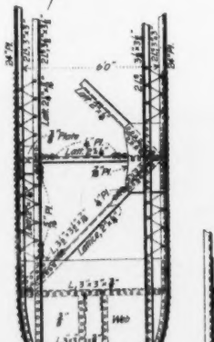


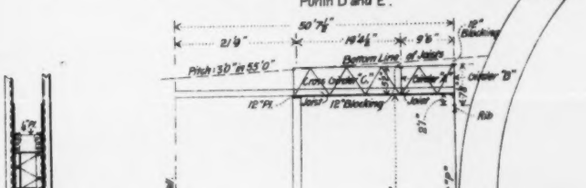
Girder "A" of Dome.

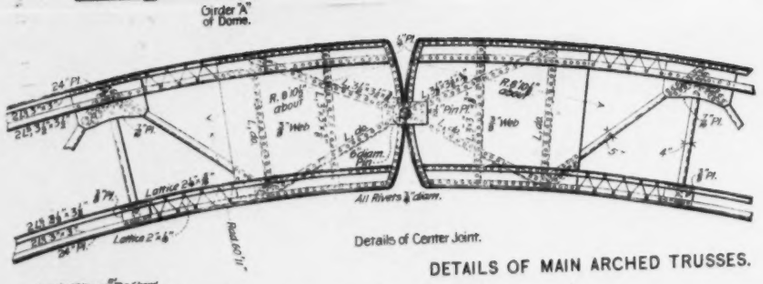


CROSS SECTION OF MAIN ROOF AND CLEARSTORY.

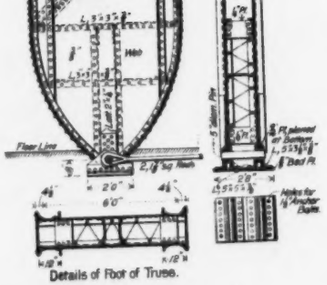

Post K
50'8" C. to C. of Main Ribs (52'2" in Panels next to Dome)
Load 40 lbs per sq. ft. + 2 Concentrated Loads.
Purlin D.
Load 40 lbs per sq. ft.
Purlin C.
Load 40 lbs per sq. ft.
Purlin A & B.
50'8" and 52'2" C. to C. of Main Ribs
Load 40 lbs per sq. ft.
Purlin D' and E'.

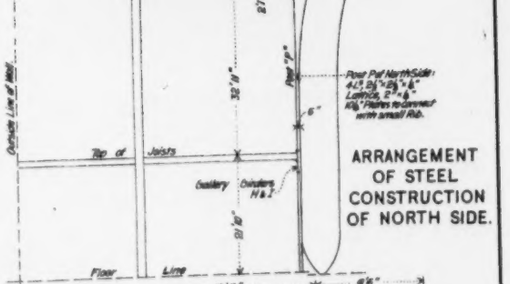


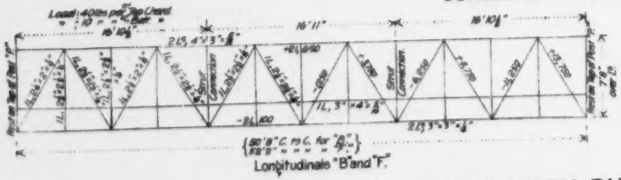


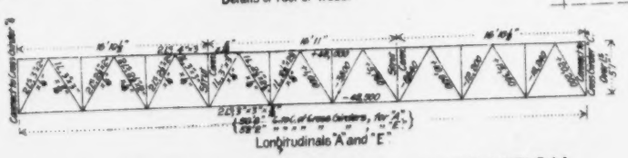


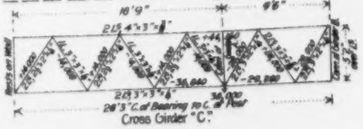
DETAILS OF MAIN ARCHED TRUSSES.











MACHINERY BUILDING; WORLD'S COLUMBIAN EXPOSITION.

D. H. Burnham, Chief of Construction. E. C. Shankland, Engineer of Construction. Peabody & Stearns, Architects.

CHAS. HART & BONS, LITH., 26 VESEY ST., N. Y.

and forth by the differential expansion of the inner and outer sheets of the fire-box and by the internal pressure tending to force down the whole fire-box. A very soft iron of low tensile strength has, as a rule, a low elastic limit. The alternate bending back and forth strains the outer fibers of the bolt at the surface of the sheet beyond their elastic limit, and the metal becomes fatigued and breaks. A stronger iron would stand a heavier strain without taking a permanent set, and would thus retain its strength unimpaired.

Car axles are another case of alternate bending strain. The fibers which are on the lower side when the axle is in a certain position and are then compressed will be on the upper side when the wheel has made half a revolution and will be stretched. We were recently shown a broken car-axle of very soft, low tensile strength steel which had failed in service by detailed fracture. The first fibers snapped under tensile strain; but before the axle had time to bend and break, this side of the axle was under compressive strain and the ends of the fibers were jammed against each other. At the next revolution a few more fibers separated, and this process continued, probably for miles, until the strength of the axle was so far reduced that the central portion snapped, showing a crystalline fracture. The outer surface of the broken section, however, was as smooth as if forged with a hammer, the ends of the broken fibers having been thrust against each other as they came on the lower side of the axle. In this case again it is plain that a metal having a higher elastic limit might have withstood the load under which this metal failed, since its fibers would not have taken that permanent set which causes gradual fatigue and eventual fracture.

We observe in the last number of the "Proceedings of the Naval Institute" a paper by Mr. George Quick, on "The Organization of Naval Engineer Forces," which contains a sentence telling a large-sized truth in very few words. We trust our own naval officers at least will duly ponder it. "No naval war on a large scale," says Mr. Quick, "has occurred to bring home to any government the importance of the engineer force on board ship; and yet scarcely a day passes that evidence is not forthcoming of the vital importance of the naval engineer, and that on him primarily rests the fighting efficiency of every navy."

If the next great naval war does not bring with it some terrible surprises we shall be greatly surprised. We believe that our navy is rather better provided with skilled engineers than any other in the world in proportion to its size, and we think that we are correct in saying also that our navy is the only one in the world in which all its line officers are compelled to take a pretty thorough course in steam engineering in order to enter the service. Nevertheless, they are not really trained engineers when they graduate, and in proportion to the duties thrown upon them the staff of engineers and mechanics on each ship is, even in our service, far less than it should be to maintain a ship in serviceable condition in time of war or in action. Every part of a modern war ship is filled with delicate machinery, and to maintain this in a state of the highest efficiency every man on them should have more or less mechanical skill, and every officer on them should be a fairly well trained mechanical engineer. After a few of these ships have been in action this truth will be realized too late. It is absurd to have no larger number of engineers on modern war ships than was common twenty years ago, when the engines were comparatively simple machines and were the only complex machinery on board.

We noted in our issue of June 16 that no less than 5 out of 20 planks of the Republican platform related to engineering questions. As we hoped and expected, the Democratic platform contains these same planks in other words, with the curious omission of that favoring the cession of the arid lands to the states or territories for purposes of reclamation. The only possible objection to this policy (but that is a serious one) is that the states would not be faithful to the trust thus laid upon them, but would permit the lands to be grabbed by sharpers and speculators. It would have been more in the line of the traditional tendencies of the same parties, however, had the Democrats proposed to intrust this work to the states, and the Republicans tacitly opposed it. The true policy on this question would probably be a mixture of state and national control. Congress should pass a carefully studied act detailing specific conditions under which the states and territories might assume and retain control of the arid public lands within their boundaries, leaving all other further legislation to the states. It is certain that this reclamation work cannot be left to private enterprize without grave disadvantages, but, on the other hand, the history of the agricultural land grant and other like concessions shows conclusively that the states cannot be trusted to administer wisely grants for which they have not asked, but which are thrust upon them by a body which thereby shirks a duty primarily its own. Any state which will show to Congress that it has a well matured plan for developing its arid lands and wishes to do something can at any time obtain the power to do it. Until each state does so it might be premature and unwise to force the problem upon them by a general act of cession.

In place of this arid land plank the Democratic platform contains one referring to river and harbor improvements, which is lacking in the Republican platform. It reads as follows:

XIV. The Federal Government should care for and improve the Mississippi River and other great waterways of the republic, so as to secure for the interior states easy and cheap transportation to the tide water. When any waterway of the republic is of sufficient importance to demand the aid of the Government, such aid should be extended by a definite plan of continuous work until permanent improvement is secured.

The last clause of this plank is eminently wise, but, alas, how little likely to be held binding after the election! The four planks on engineering questions which are common to both platforms compare as follows:

V. We favor the extension of our foreign commerce, the restoration of our mercantile marine by home-built ships, and the creation of a navy for the protection of our National interests and the honor of our flag.	X. . . . . We favor the maintenance of a navy strong enough for all purposes of National defence and to properly maintain the honor and dignity of the country abroad.
VIII. We favor efficient legislation by Congress to protect the life and limbs of employees of transportation companies engaged in carrying on interstate commerce, and recommend legislation by respective states that will protect employees engaged in state commerce, in mining, and manufacturing.	XIX. We favor legislation by Congress and State legislatures to protect the lives and limbs of railway employees and those of other hazardous transportation companies, and denounce the inactivity of the Republican party, and particularly the Republican Senate, for causing the defeat of measures beneficial and protective to this class of wage-workers.
XIV. The construction of the Nicaragua Canal is of the highest importance to the American people; but as a measure of national defence and to build up and maintain American commerce it should be controlled by the United States Government.	XV. For purposes of National defence and the promotion of commerce between the states, we recognize the early construction of the Nicaragua canal, and its protection against foreign control as of great importance to the United States.
XVII. The World's Columbian Exposition is a great national undertaking, and Congress should promptly enact such reasonable legislation in aid thereof as will insure a discharging of the expense and obligations incident thereto and the attainment of results commensurate with the dignity and progress of the Nation.	XVI. Recognizing the World's Columbian Exposition as a national undertaking of vast importance, in which the general government has invited the co-operation of all the powers of the world, and appreciating the acceptance by many of such powers of the invitation extended, and the broadest liberal efforts being made by them to contribute to the grandeur of the undertaking, we are of the opinion that Congress should make such necessary financial provision as shall be requisite to the maintenance of the national honor and public faith.

All four of these planks appear to mean substantially the same thing in both platforms, with the possible exception of that relating to shipping. The planks with regard to the Nicaragua Canal seem to indicate a strong public sentiment in favor of its construction under Government auspices and control. Both parties seem equally afraid to say more on the immigration question than that they "denounce" criminal, pauper and contract immigration, but favor "the immigration of the industrious and worthy," which goes without saying. Where the industrious and worthy line shall be drawn, however, is a question which both parties dodge. Draw it strictly and how many of the present half-million yearly could pass it?

RESULTS OF COMPOUND LOCOMOTIVE TESTS.

Elsewhere in this issue we give the conclusion of the discussion at the Master Mechanics' Convention on the report of the committee on compound locomotives, and the facts which were presented therein are worth the careful attention of railway officials. A more thorough examination of the committee's report confirms our first impression that the facts which were brought out in the discussion have a much greater practical value as evidence of the actual economy of the compound locomotive in regular service than the report itself.

We are in entire accord with the criticism made on the report by a member of the association, which was to the effect that so many variables entered into the committee's tests that it was extremely difficult to tell what the results obtained really showed. We alluded last week to the mistake made by the committee of assuming that working both engines at the same boiler pressure, although the simple engine was designed for 180 lbs. and the compound was designed for 200 lbs., would give results fair to both engines. An examination of the diagrams published in our last issue will show that the compound showed a great loss in economy when worked at a steam pressure 20 lbs. less than it was designed for. On the other hand, the simple engine showed on the whole no greater economy in fuel at 200 lbs. than at 180 lbs., and in some cases a decided loss.

Another important point in which the committee's report is likely to mislead is that it purports to show the percentage gain in fuel economy by compounding in average freight train service. Now let us see just what service was really given to the locomotives. On reference to the tables we find that 60 runs were made between Milwaukee and Portage, a distance of 92 miles. The average train hauled weighed 632 tons. The average time spent in running was 4 hours and the average time spent in stops was 2 hours. On nearly every run the engine was required to do more or less switching, and this is largely the explanation of the large amount of time consumed in stops.

Probably very few engineers would expect much, if any, fuel economy from the use of the compound locomotive in switching service. The steam used by a switching locomotive is not very great, and the compound locomotive has a larger extent of cylinder surface and weight of cylinder saddle to warm up every time a start is made than a simple engine of the same power. As an example of the fact that other multiple expansion engines do not show to advantage where the labor is intermittent, the triple-expansion engines of the ferryboat "Bergen" may be cited. This boat plies on the North River, making trips about a mile and a half in length, and her engines have been found to be less economical than compound engines for the same service.

It is, of course, true that compound locomotives may yet be shown to have marked advantages for use in switching on account of their ability to start a heavy train and get under way rapidly. They may even be proved to be economical in fuel on account of their much lighter exhaust, which saves tearing the fire and throwing unburnt coal out of the stack. As far as the use of the steam in the cylinders is concerned, however, it seems safe to say that a compound locomotive, if it shows any gain over the simple engine, will show much less gain than it would in running on the open road.

The length of the stops and the considerable amount of switching done seems to be one reason for the low average gain in economy (7.6%) for the compound engine which the committee's tests showed. Another reason, and one on which much stress deserves to be laid, was the great variation in the weight of the trains and the character of the service. The compound locomotive, according to general experience, makes the greatest saving in fuel when worked to its fullest capacity. No one would expect the compound locomotive to burn much less than the simple engine, if both were run over the road light; and where the train is far below the locomotive's capacity the saving in fuel would certainly be expected to be comparatively small. Now, while the trains hauled in the committee's tests had on a few trips a weight of between 800 and 900 tons, the average was only 623 tons, and trains of 450 tons or less were quite numerous.

The committee, however, in summarizing the percentages of saving, has paid no attention to the varying weight of the trains hauled, but averages all together. It is plain enough that such averaging is likely to show entirely incorrect results. It may be that more light trains fell to the compound engine than to the simple, or it may be the other way. A good example of errors likely to occur when tests are made in this way is given in the committee's summary of its report, which we reprinted last week (p. 638). They say that the result of using Pittsburg coal instead of Braceville in the two engines was a saving in the steam used per horse-power hour of 9.2% in the simple locomotive and 6% in the compound. How the use of better coal could affect the amount of steam used in the cylinders to produce a given power is a problem that we cannot solve. If there is steam enough to supply the engine and none is wasted in blowing off, a change in coal has no more effect on steam consumption in the cylinders than a change of the engine driver's hat. The main reason for the greater economy in the use of steam when Pittsburg coal was burned seems to have been the fact that the weight of the train happened to be 5% greater on the average than when Braceville coal was used.

Summing up, then, our position is that it is largely labor lost to make a long, complicated scientific test of this sort on a freight engine running "first in, first out" on all classes of service. Tests of compound locomotives under variable conditions of service are highly desirable; but if the enginemen are properly instructed, the engines may safely be left to make their own record and let the monthly performance sheet tell the story.

Turning now to the very interesting record of experience with compound locomotives contained in the discussion at the convention, which we report elsewhere, we wish to call especial attention to some points of great importance which were put before the convention in an admirable manner by Mr. R. H. Soule. In the first place, it is continually urged that it is not fair to test the simple and the compound engines at different steam pressures. Now, if it were true that the simple engine could make a gain in economy by working at 200 lbs. steam pressure, there would be, perhaps, some ground for this criticism. The facts are, however, that the simple engine reaches the limit to the economical use of high-pressure steam before the compound. Hence the gain made by the economical use of higher pressure steam is fairly counted to the credit of the compound.

The most interesting point in reference to the compound locomotive, however, is its increased capacity over the simple engine. All those who have had experience with compound locomotives agree that in the hard work of starting a train, keeping up speed with a heavy express, or hauling a freight train up a grade, the compound will beat the simple engine. The reason for this is simple. The compound locomotive gets more power out of a given amount of steam, and since the power of a locomotive when running is invariably limited by the ability of the boiler to furnish steam, it is apparent that the effect of compounding is to increase the capacity of the engine.

It is pretty certain, as Mr. Soule pointed out, that this advantage will very soon be appreciated by other railway officials than those in the mechanical department. If the compound locomotives will haul two or three more freight cars over the hill, will make time with the "Cannon-Ball Limited," and will make possible some shortening in the time of suburban trains on account of its ability to get under way rapidly, there is likely to be a pretty active demand for compound locomotives soon after this fact is clear. It is noticed that the higher officials have already taken a prominent part on many roads in the introduction of the compounds, and they are likely to urge still more rapid progress as the facts stated above come to be appreciated.

A gain in capacity of 5 to 10% and a gain in economy of 15 to 30% are advantages not often combined. Each is worth considerable expense to secure, and both together seem destined to bring about a large reduction in locomotive expenses as well as an increased efficiency of service.

What is blinding many men to the advantages promised by the compound engine, including some of those who pose as authorities, is this: They are in the habit of thinking of the advantages promised as merely a saving in fuel consumption, the same engine doing the same work with less coal. The English discussions especially are notable for this peculiarity. We do not remember to have seen even a hint in any English periodical that there was any other side to the compound engine question than mere fuel-saving. Under the conditions of English practice, with such light and weak cars as to forbid the handling of light trains, this may not be so far wrong.

Under the conditions of American practice, however, it is a grave error; as grave as if one had allowed the question of using consolidation engines to turn on whether or not they would burn less coal to haul the same train than the older type. The consolidation engine would make a poor showing on this basis, but the real question was, will it show more work done for a given cost of train service? And on that basis the consolidation engine comes out far ahead in most cases.

Similarly for compound engines, the real question is: Is it or is it not worth while to get from 10 to 25% more steam out of the same coal and the same boiler by paying some $750, more or less, for the locomotive? That is what the compound engine does in effect, by making the same quantity of steam go further in work. We can use that surplus steam in any one of several ways. We can (1) use it to run faster than we otherwise could, from lack of boiler capacity, or (2) we can use it to help freight trains up the long hills where they are now likely to stall from lack of steam, or (3) we can use it to modify the design of the engine, throwing more load upon the drivers than we could otherwise utilize for lack of steam power, and thus increase the all-around capacity of the engine; or, finally (4), we can choose the poorest way of all according to American ideas and American practice, and say we will not use the steam at all, but rather save the coal it would take to generate it!

That this latter use of this surplus steam—mere coal-saving—is excessively wasteful may be seen at once by considering that the power which that steam represents, if it be used instead of saved, will result in hauling more cars without any increase in engine or train wages, with practically no increase in maintenance of way (since there is no increase in engine mileage), with no proportionate increase in the cost of engine repairs, and with no increase at all in the station and other general expenses. And yet this poorest of all methods of using the surplus steam, not to use it at all, is the one most talked about!

LETTERS TO THE EDITOR.

EMPIRE STATE EXPRESS.

Sir: In your issue of June 9, on p. 584, it reads: "By the regular schedule the train takes 5 hrs. 40 m. to run 440 miles." Is that not misleading?

Respectfully, Subscriber.

(This was a typographical error, and should have read 8 hours 40 mins., the train leaving New York at 8:30 a. m. and arriving at Buffalo at 5:10 p. m.—Ed.)

HEIGHT OF BACKWATER FROM DAMS.

Sir: In your issue of May 5, Mr. Frank H. Greene asks for a method of determining the height of backwater (overfall) from dams for different stages of the streams upon which they are located. Mr. Greene will find a very elaborate discussion of this problem in the report of the Chief of Engineers, U. S. A., for 1887, Appendix Q, pages 1,305—1,317. Very respectfully,

D. M. Andrews.

Coosa Valley, Ala., May 9, 1892.

(We have delayed publishing this letter in order to look up the article referred to, which is too detailed for us to attempt to publish, but which appears to cover the desired information fairly well.—Ed.)

HUSSEY RE-HEATER SYSTEM—PERSONAL.

Sir: It having been brought to my attention within a day or two that printed matter is being circulated wherein my name appears as General Manager of the "Hussey Re-heater and Steam Plant Improvement Co.," I would state that I have not been connected with that company for over two years. How long my name has been used in the manner mentioned I do not know, but I wish, even at this late day, to state that I am not interested, either directly or indirectly, in any business except my own. Within a few months I have individually secured the exclusive right to manufacture and sell the Hussey Re-heater System.

Very truly yours, S. D. Brewer.

New York, June 18, 1892.

MISSISSIPPI RIVER DISCHARGES.

Sir: I mail to you herewith "Tabulated Results of Discharge Measurements on the Mississippi, Ohio and Atchafalaya Rivers and Crevasse and Overflow Measurements, 1891." The most noteworthy results published in this pamphlet are the low-water measurements at various stations, which show a smaller discharge than ever before recorded.

The difficulty of the problem of the improvement and control of the Mississippi River may be inferred from the facts that it is necessary to secure a continuous navigable channel and bank protection for at least 1,200 miles of a river whose discharge varies from 80,000 to 1,600,000 ft. per second, and whose elevation of water surface, at some points, ranges over more than 50 ft.

Yours truly, Geo. H. Johnson.

St. Louis, Mo., June 20, 1892.

SMOKE PREVENTING DEVICES.

Sir: Can you inform me if any paper on the matter of smoke preventing devices has been read before any of the engineering societies lately? I have seen such an article, but do not remember where. The paper in question treated rather fully on the application of a steam jet and gave in detail the report of several trials, together with the relative costs of operation. Any light you may be able to furnish me bearing on the above will be fully appreciated. Yours very truly,

I. Lincoln, Jr.

Chicago, Ill., June 17, 1892.

(Several smoke preventing devices were mentioned in papers and discussions on "Smoke" recently presented at meetings of the Engineers' Society of Western Pennsylvania, and noted in our columns. We have also from time to time published descriptions of devices of this kind for locomotive and other furnaces, and we have various others on hand for publication, but in the meantime the smoke still smokes.—Ed.)

CONSTRUCTION OF CONTRACTS.

Sir: Will you please give us your opinion on the following questions in your paper: 1. Can an engineer ask for 9 ins. of macadam, the contract calling for 6 ins. of broken stone (2½-in ring) and 3 in. of gravel, both 16 ft. wide? The price is per cu. yd. of material and 8 cu. ft. of stones and 4 cu. ft. of gravel, are figured per lineal foot, making no allowance for gravel to go between the rocks. 2. Having a contract per lineal foot of terra cotta pipe, laid across the roadbed, can the engineer pay by counting joints or has he to pay by actual measurement? Respectfully, V. & K.

Birmingham, Ala., June 15, 1892.

(1. He can ask for it, but he cannot get it except under the express or implied power which is a part of most contracts, to change plans during the progress of the work with corresponding change of price. He can compel the contractor (in most cases) to furnish 50% more material at the same unit price, but he cannot make changes to the disadvantage of the contractor without compensation. 2. Intent or general custom, clearly proven, will always govern, but "lineal feet" of anything must be measured off by the tape line on demand of either party, except where intent to overreach might be clear, as, for instance, an attempt to stretch out sewer pipe by not butting them close together at the joints. No one can successfully invoke strict construction to defend sharp practice.—Ed.)

THE MAGNETIC AND INTERNATIONAL ORE SEPARATORS.

Sir: Several of the technical journals have recently published notices emanating, evidently, from the Magnetic Separator Co., of New York, stating that a suit had been entered in the U. S. Court for the district of New Jersey, against the International Ore Separating Co., of New York, for infringement of patents. We will be greatly favored if you will publish in your columns the following true statement of the matter:

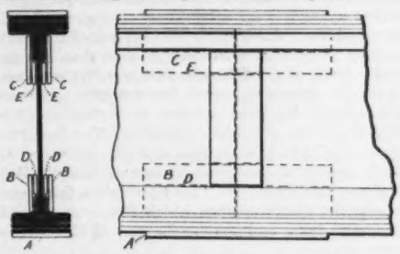
The statement that suit has been brought against us by the Magnetic Separator Co. or by any other person, firm or corporation, is unqualifiedly false. The International Ore Separating Co. operates under patents assigned to it, which infringe no other patents whatsoever, while eminent counsel have repeatedly advised that the claims of the patents of the Magnetic Separator Co. are invalid, and this the International Ore Separating Co. stands ready to prove before any court of law or equity. By the actual practical results of separation, as well as by the opinion of those best

qualified to judge, the separators built by the International Ore Separating Co. are superior by reason of their simplicity, cheapness, durability and efficiency to all others now on the market. The especial features of these separators are absolutely new, the spirally wound drums of small diameter, the special forms of magnet with consequent poles, the method of transference from drum to magnets, the combination with these of a belt and rollers, together with the method of operation under the surface of water, are all completely protected by United States and foreign patents, and any infringement of these will be promptly prosecuted. International Ore Separating Co.

New York, June 18, 1892.

WEB SPLICES.

Sir: It is a common practice to consider one-sixth of the area of web plates in the flange section of plate girders, and to make up the section at web-joints by a cover plate (A, on accompanying sketch) on top of the flange plates. The flange strain carried by the web must then be transferred through the flange angles and cover plates to the splice plates, and back again to the web. As the angles and plates are already strained to



Splicing Web Plates.

their full allowed value, it is hard to see how the strain is to get to the cover splice.

It might be said, perhaps, that the splice plate transfers some of the strain carried by the cover plate next to it, and the plate thus relieved carries some per cent. of the strain in the next plate, and finally, the angles thus relieved transfer the web strain direct; but where there are several cover plates the method is at best a clumsy one. The web section should not be considered in the flange area or else the web should be spliced by plates riveted direct to its faces, as shown on the accompanying sketch.

Yours truly,

Chas. H. Wright.

Wilmington, Del., June 6, 1892.

(Our correspondent's point is well taken and measurably so whether the web areas be taken into account in computing the flange sections or not. It is to be remembered that what we may or may not choose to assume does not affect the actual distribution of the strains. In any case the web will act somewhat, and the actual working flange will be more or less of an inverted T section. By cutting away the stem of the T we nick the flange, so to speak, causing an irregular excess of strains just below the nick. A 1-in. rod may be sufficient to sustain a given strain, but if we increase it to 1½ sq. ins. and then nick away one-third of this section at intervals, we are by no means in the same position as if we had used the inch rod throughout; nor does it compensate for the effect of a non-continuous web not to regard it in computing the flange sections.—Ed.)

PILE DRIVING FORMULAS.

Sir: I suggest the following modifications of the so-called Engineering News pile driving formula, so that it shall include the two elements of length of pile in the ground and diameter of pile, which obviously affect the sustaining power greatly.

$$L = \frac{l\,d\,w\,h}{5\,(s+4)}$$

in which s = penetration at last blow (inches).
l = length of pile in ground (feet).
d = mean diam. of pile ground (feet).
w = weight of hammer (pounds).
h = fall of hammer (feet).
L = safe load (pounds)

John F. Ward.

(By this formula a pile which had been driven twice as far into the ground, or which happened to have twice the diameter, would have twice as much sustaining power, even if the penetration per blow had been the same, which is absurd. A pile of twice the diameter which happened to have been driven twice as far would have four times the sustaining power, though both piles alike had taken, say, 18 blows to sink the last 36 ins.; which is still more absurd. The elements of length in ground and diameter do, indeed, have great effect on the sustaining power of the pile, but their effect is already expressed (and more accurately than it can be in any other way) by the set (s) under the last blow. To attempt to express this effect twice over is wrong in principle and can only lead to error. The so-called Engineering News formula

$$L = \frac{2\,w\,h}{s+1}$$

was originally given as merely a handy practical formula which corresponded accurately with observed facts, because at the time we were discussing only that side of the question; but as a matter of fact it was and is much more than this. It is claimed to be theoretically perfect in its form as well as practically convenient. Even the constant (1) is not an arbitrary element, but one which in theory should be constant and in theory should be about (1). We shall take occasion shortly to discuss this whole subject, which has been much and needlessly muddled by technical writers.—Ed.)

THE NATIONAL BRIDGE & IRON WORKS.

Sir: Your issue of June 16 contains a letter signed by Geo. A. Carpenter, City Engineer, Pawtucket, R. I., seeking information about the National Bridge & Iron Works of Boston. As he seeks information through your columns, I reply by the same medium. His information that the Company was ruined by the failure of a railway bridge while being tested is not correct. No such thing ever happened at any time. The company went out of existence in 1875 from no reasons pertaining to the character or quality of its work, after having built many millions of dollars worth of iron bridges and roof trusses, almost all of which are now standing and doing good service. Although 18 to 25 years in use they will compare favorably with the best practice of to-day, both theoretically and mechanically. I am not aware that to this day any failure of any of its work has ever occurred. No doubt some of its bridges have been replaced by new ones to meet the demand of increased weight of traffic.

The Pawtucket bridge was built to specifications approved by a regularly appointed consulting engineer, the late S. B. Cushing, of Providence, R. I. The engineer in immediate charge of this work was (I think), a Mr. Singley, C. E., then of Providence. When the bridge was completed, a test, as called for, was made by loading the bridge over its whole floor surface with 8 ins. depth of gravel. Its deflection was noted, as well as its subsequent recovery after removal of load. Some other tests with concentrated loads on four wheels were also made, which I do not remember.

All the strain sheets, sections, specifications, conditions and record of tests, were matters of record at the time and are doubtless obtainable now, either at Pawtucket or through the office of Mr. Cushing, at Providence. They were considered ample and satisfactory at the time.

I have been informed, mainly through the local press, that for some reason, I know not, parties are divided in Pawtucket. One is determined to condemn and sacrifice the bridge, and the other is determined to have it put in proper shape and condition. I have declined heretofore to take sides or enter this dispute. The bridge is a fair sample of good practice to-day. Unless I mistake greatly the nature of the travel over it, I do not hesitate to say, that if properly adjusted and put in as good condition as it was originally, it will do good and safe service for many years to come. The crossing over of a heavy steam road roller might not be advisable, and is, I think, unnecessary, as there are other routes available; and as this seems to be one of the disputed points, it would seem foolish to sacrifice the bridge for it. I have not examined the bridge for many years, but I know it never was a cheap or a badly designed or constructed one, and the interests of Pawtucket were guarded and protected at the time by the committee and their consulting engineer. Respectfully yours,

Chas. H. Parker, M. E.,
Late Chief Engr. Nat'l Bridge & Iron Works.

Cambridgeport, Mass., June 24, 1892.

(The long-span bridge which was built 18 to 25 years ago, and yet compares favorably with the best practice of to-day, both theoretically and mechanically, certainly ought not to be destroyed. It should be preserved as a remarkable mechanical prophecy. The load of gravel specified amounts to 60 or 65 lbs. per sq. ft. No one can say that such a load was not and is not warranted by good practice when accompanied by an adequate rolling load. But it is the very lowest distributed live load which is warranted by good recent practice, and for a bridge near a large city should be at least 50% greater.—Ed.)

THE "BACK PILING" OF WATER BY DAMS AND OBSTRUCTIONS.

Sir: I send you the following notice of a singular legal decision in which positive proof was ignored through an alleged want of expert evidence on the back piling of water.

The opinion of Justice Putnam, handed down with his decision of the action of John B. Newland, of Stillwater, N. Y., and another against the Hudson River Water Power & Pulp Co., dismissing the complaint, does not touch the law questions involved therein by the scientifico-legal claim that the defendant's dam "piled the waters" of the Hudson by the obstruction of their dam back beyond the "ripple" that exists where the level of the pond reaches the natural current. Instead, he decides the action solely on questions of fact, by finding that the plaintiffs do not show by a preponderance of evidence of expert engineers, etc., that such piling does exist, or, that if it does, it is occasioned by the fact of defendant's dam having been erected. The finding being for the defendant on questions of fact, instead of a non-suit on questions of law, the matter of a successful appeal therefrom appears quite doubtful. "Paper Mill Journal," Nov. 20, 1890.

In 1882 The Hudson River Water Power & Paper Co. erected a dam across the Hudson River at Mechanicville, N. Y., under an act of the Legislature, in which act there was a special provision that "the dam should be so constructed as not to interfere with the water power at Stillwater or any intervening water power." The plans for the dam in question, which were exhibited before the Legislature, called for a structure 14 ft. high with a spillway or overflow of over 900 ft. in length.

The dam as constructed, against the protest of the engineer in the employ of the company, is 16 ft. high with a reduced length of spillway. In addition to the increased sectional obstruction in the main bed of the river, the company constructed a dike 8 ft. high and about 800 ft. long across a meadow at the easterly end of the dam, which was contemplated for an easement in time of extraordinary freshets.

As a result of the obstructions to the natural flow of water in the rivers caused in part by an ice jam, from a tributary stream, the Hoosac River, the intervening water power, the Howland mill, located about one mile above defendant's dam, became seriously injured. A second freshet by the "back piling of water" carried this dam away and dismantled the entire mill property. Since this event there has been a continuous inclined pond on the west side of the river, causing an increased depth of water over the Newland wheel pits at Stillwater, about two miles above defendant's dam. On the easterly side of the river below the entrance of the Hoosac ripples exist in the stream, but the rocks are never bare. Notwithstanding there is a fall of about 7 ft. to defendant's dam.

On the trial of the case before Judge Putnam, which continued during two years, it was clearly established by competent witnesses that the claims of the plaintiff Newland were correct, not only as to the flooding of the water wheels, but also of island property which entered into the complaint. No evidence was introduced by defendant to disprove this, excepting by the theoretical statements made by their experts, who pronounced the same "physically impossible."

Judge Putnam, in his findings, decides that the plaintiff, through two competent and reliable witnesses, whom he names, establishes the fact of the setting back of the water, but he follows this up with the most extraordinary statement that because the plaintiff did not show by a preponderance of expert evidence that the defendant's dam causes the trouble, he must decide against the plaintiff. Judge Putnam also says it was incumbent upon the plaintiff to show similar effects at other places. The defendant's counsel would not have admitted such evidence, which would have been clearly out of place—but as the back piling of water has commanded some attention recently, a few facts bearing upon this subject may be of interest.

The dam at Troy, erected by the State, a structure 8 ft. high across the Hudson River, is frequently obliterated from view, being entirely submerged. This, the writer claims, is mainly, if not entirely due to the back piling of water caused by natural and artificial obstructions in the river below the dam. The several small islands, the bridge piers and abutments, and especially the quick bend and narrow channel of the river at the iron works, all contribute to set the water back over the dam. This back piling of water does not stop at the dam, but continues above the same in a descending or ascending plane, augmented by the extent of the freshets.

Back piling may be caused without obstructions in the river. During a long continued easterly blow off of the coast of Long Island in the summer of 1888, which caused a rise in the bay at New York, the water in the Hudson was piled back to the Troy dam, causing an elevation of 3 ft. above its normal condition.

In 1882, the time the defendant's dam was being constructed, surveys were made at Hewlet's Landing, 17

miles from the outlet of Lake George, and it was clearly demonstrated that an additional obstruction of 2 ft. elevation piled the water back over the meadows at the point named.

In an action recently tried at Ballston, N. Y., growing out of "drowned lands" surrounding Saratoga Lake, it was clearly shown that the lake has been gradually rising during the past few years. The defendant's exhibits were maps and profile showing that the waters of the lake (embracing an area of 7 sq. miles), are held at an elevation of over 4 ft. above its normal condition, and that the waters of Fish Creek, the only outlet of the lake, are piled back to the outlet surface of the lake, describing a descending plane to the first dam on the creek below the lake.

The waters at Niagara Falls were piled back in 1848. The winter of 1848 had been a severe one, and ice of unusual thickness had formed on Lake Erie. The warm spring rains of March loosened this congealed mass, and on March 29 a brisk east wind drove the ice far up the lake; about sunset the wind suddenly veered around and blew a heavy gale from the west; this naturally turned the ice in its course, and bringing it down to the mouth of the Niagara River, piled it up in a solid impenetrable wall.

"So closely was it packed, and so great was its force, that in a short time the outlet to the lake was completely choked up and little or no water could possibly escape." The water then piled back on Lake Erie.

"To thorough appreciate this astonishing phenomenon, it should be remembered that the estimated average amount of water passing over the falls is 502,500 tons per minute." This condition of affairs lasted nearly a whole day with scarcely any water passing over the falls.

Returning to the case in question. There was no attempt on the part of the plaintiff to establish proof by expert evidence. It was shown, as the judge says, that there was positive and reliable proof on the part of the plaintiff that water has set back over the plaintiff's wheels since the construction of defendant's dam. It did not require any "scientific legal evidence," as mentioned in the "Paper Mill Journal," to prove this; the judge admitted that it was sufficiently established.

This case has just been argued before the Court of Appeals. It is probable that it will be sent back for a new trial.

Peter Hogan, C. E.

Albany, June 10, 1892.

(We have an article on this subject which we shall publish shortly.—Ed.)

THE CAST IRON LINING OF THE HUDSON RIVER TUNNEL.

Sir: Permit me to offer some remarks upon the editorial under the above caption in your issue of June 16, p. 609.

It is quite true that the Hudson River silt is a much more difficult material than the soft clays of the St. Clair and Lake tunnels; not that it is more fluid, but by reason of its want of cohesiveness. The cast iron segments designed in London, with which the work was commenced, were made too light, as demonstrated by later experience, and their radial joints were not planed. In the portion of the tunnel built with these segments, fine cracks have occurred, not at the sides, but in the flanges of the key. A tie has been placed close under the key to restore the tensile resistance of the flange; and to prevent further distortion, a second temporary tie is inserted across the center of the ring. As soon as the weakness of the original segments became apparent the patterns were changed, the segments were made much stronger, and the radial joints were planed. Although adding appreciably to the cost, the planing of the joints has been quite as effective as any other modification in preventing distortion and facilitating the erection of the rings. All cracks and deformations are confined to the portion built with the earliest segments.

It is also true that the bending moments of the ring immersed in a fluid are due to the variations of pressure from the top to the bottom, and are independent of the depth of immersion. But there is a tangential force in addition to the bending moment, a pressure which increases with the depth, and reduces the tension on the metal of the ring, wherever it exists. This is an important consideration in the present case.

Your diagram does not represent the relative pressures on the ring except for the depth given. The greatest tension on the metal of a submerged ring is when the top of the ring is fair with the surface of the fluid.

Cast iron is certainly not the best material to resist transverse stresses. But there are other requirements in the shell of a tunnel, and it will hardly be denied that a cast iron shell can be made strong enough. The earlier brick tunnel has a better form (elliptical) to resist the silt-presseure, and the brick work is of great thickness. It was probably subjected to tension at some points when first built.

The vibration which, it is assumed, will be caused by the passage of trains, is referred to as a probable source of danger. No vibration or tremor can be perceived due to any weights heretofore moved in the tunnel, and the consideration of the great mass of the silt in which it lies, and of the normal pressure upon the tube (300,000 lbs. to each lin. foot of tunnel), has encouraged the belief that none will be caused by the passage of trains. Nevertheless, if vibrations should occur, and if they should render the silt more fluid, the bending stresses would be diminished; not increased.

Comparing the Hudson River and the St. Clair tunnels, it is probable that the material in which the latter lies is as soft as the undisturbed silt of the Hudson River. If that be so, the bending moments are some 30% greater on account of its greater diameter. The moment of resistance of the cast iron shell is about the same as that of the Hudson Tunnel. The partial lining of brick or concrete does but little to stiffen it; no distortion has taken place.

The new Blackwall tunnel is a very different affair. It lies in Thames ballast, through which water passes as through a sieve, and the difficulties are of another nature altogether. The diameter of the tunnel is more than a third greater than that of the Hudson Tunnel. Its section is nearly twice as large, and the work of the contractor involves the construction of considerable lengths of sewers disturbed by the approaches. The prices bid for it are no guide to the cost of the Hudson Tunnel.

The most serious element of cost of the latter arose from the necessity to erect the shield 2,000 ft. from shore in an enlarged chamber constructed for the purpose. The cost was also increased by various accidents and difficulties, not likely to occur again with the experience gained. Yet the sum received by the contractors has but little more than half the amount assumed to have been paid them.

Wm. R. Hutton.

New York, June 28, 1892.

Since writing the foregoing I have been informed by Mr. Hobson that in the St. Clair Tunnel not the slightest tremor can be perceived during the passage of trains.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XII.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

Prof. Rogers' draft of the "Objects and Plan" of the Institute of Technology (Oct. 5, 1861), while a long way in advance of the crude plans which had before existed for creating a scientific institution in the Back Bay lands, were a long way behind those which he was to form and announce as the "Plan and Scope" of the institution in 1864. The contrast between the two is most interesting, especially in the fact that most of the impracticable and objectionable features of the 1861 document had been quietly dropped by 1864, while the good features were retained and expanded.

Prof. Rogers' plan of 1861 was for a triple organization of a Society of Arts, a Museum or Conservatory of Arts, and a School of Industrial Science and Art. Their relative importance, in his mind at that time, was stated to be in about the order given. Their actual importance was in inverse order. The "Society of Arts" was to be an association of grown men, who were to zealously devote themselves to the acquisition of further knowledge (which grown men rarely do) and to the dissemination of knowledge, which few men do for very long, except as it is their profession to do so. "As an important feature of the plan" they were to establish a periodical which should "furnish a faithful record of the advance of the arts and practical sciences at home and abroad;" in other words, which should subserve the same function as Engineering News and three or four other privately conducted journals do at the present day. At that time none of these journals existed, nor did most of their prototypes abroad. The only scientific publication in this country worthy of the name was then the "Journal of the Franklin Institute," the Franklin Institute being a body seeking to subserve the same functions as the proposed "Society of Arts." Prof. Rogers expressed confidence that "a journal devoted to these objects, ably and powerfully conducted, would prove an invaluable help in carrying forward the plans and promoting the success of the institute," which is doubtless true. The difficulty was that journals managed through a "committee on publications," controlling hired editors, were not likely to be "ably and powerfully conducted." They never have been and probably never will be. This feature, therefore, was wholly impracticable, though all the precedents there were rather tended to indicate its feasibility. The impracticable nature of the rest of this part of the scheme will best be seen by quoting what the duties were to be of the tenth of the twelve technical committees of the "Society of Arts," that on "engineering and architecture:"

"To this committee will be referred all questions relating to the qualities and applicability of the materials used in buildings or other structures; the survey, location and construction of railroads, canals, bridges, reservoirs, aqueducts, paved avenues and tunnels; the arrangement and decoration of open squares, the planning and erection of dwellings and of buildings for commercial, manufacturing and educational or other public purposes, and, in a word, all the diversified works which come within the province of the architect and civil engineer, together with" some other things which we need not enumerate.

Volunteer expert work of this kind, done in committees of non-specialized societies, and done in gross for all sorts of subjects, and not for some particular subject to fulfill some special need, is necessarily all but worthless. Accordingly this branch of the work has never amounted to much, any more than has the similar work of the Franklin Institute. It is an unreasonable dream to expect the contrary. Individuals inspired by some mission may thus sacrifice themselves, but not whole societies. The Institute "Society of Arts" holds semi-monthly meetings, at which occasional important inventions like the Bell telephone are announced. They publish a thin yearly pamphlet of proceedings which few ever see and fewer still read, and that is the end of their functions.

The museum part of the scheme has also not come to much as yet, except in connection with the school of the Institute. The scheme for the museum, however, was well drawn, and may be expected in time to materialize substantially on the lines sketched by Prof. Rogers, which were substantially those of several successful foreign museums, notably that of South Kensington, which at that time was a small affair compared with what it is to-day.

The third part of the scheme, the industrial school, Prof. Rogers declares in the beginning that he is not yet prepared to outline definitely. He only seeks for "its practical recognition in the beginning as an integral part of our scheme, however imperfectly carried out." He did in terms disclaim, however, any present intention to form what subsequently was formed, a thoroughly organized and complete college of engineering. "It will be seen from the peculiar character and objects of this department of the Institute that it could not interfere with the interests of the established schools of learning devoted to general literary and scientific education. Aiming to supply the industrial classes with a knowledge and training of which they are specially in need, and which it would be incompatible with the purpose and organization of the universities and colleges to attempt to provide, it would, we feel assured, command the good wishes and active sympathies of these scholars and men of science who dispense the high instruction of those schools." Not thus does the institution as finally organized take off its hat to the "high instruction" of any other scientific school whatsoever. Within its sphere (which is almost as broad as applied science) it aims to give as high instruction as can be obtained, and speaking broadly, and ignoring small distinctions, it may fairly claim to do so. This it does too by Prof. Rogers' own advice and initiative, after three years' more pondering on the subject. He then saw, what we believe to be the truth, that a school may successfully give half knowledge to a few as an adjunct to giving full knowledge to those who seek it, but that a school which aims at giving half knowledge only to a multitude who would otherwise get none, though it may seem to be subserving a useful function, will not command public interest and support. The school as outlined in this first pamphlet, while it had several splendid features which have been preserved and made the final institute more successful, would never have been respected or respectable without further expansion of its scheme.

It was to consist primarily of five "schools," the School of Design, the School of Mathematics, the School of Physics, the School of Chemistry, and the School of Geology. The last only was to be a true engineering school, and that an imperfect one. Had the term then been a familiar one, it would have

been more accurately termed a school of mining engineering than a school of geology. The "School of Design" was to be what is now known by that name, teaching all forms of industrial design for glass ware, pottery, iron, brass, paper, cloth, etc. This is a great and ever widening profession, but it has no considerable connection with the work of the polytechnic school, properly so called, and hence it gains nothing by being intimately connected with it. The desired School of Design now exists in Boston (and badly needs a "South Kensington Museum" in connection with it, as do the similar schools in other cities), but it is not a part of the Institute of Technology.*

The schools of mathematics and physics were to be "necessarily limited to the simpler lines of investigation," and to "the humbler grade of preliminary attainment." They seem to be outlined so as to cover potentially all departments of mathematics and physics, however, and the only error made seems to have been the effort to give too popular a character to them, could be made useful and acceptable to "the mechanic, engineer, architect and manufacturer."

The School of Chemistry was to be substantially what it now is, except with more of a leaning toward mere artizan instruction, but in describing it Prof. Rogers lays down what was perhaps his greatest contribution to this and other polytechnic schools, viz., that "in this and the preceding departments" personal training in analysis and experiment, in well-appointed and ample laboratories, was necessary for the best progress of the student. The idea was not in itself new even then; to-day it is a truism; but in the extent to which it was practically recognized and applied the M. I. T. took the lead, and this had much to do with its early and great success.

Such was the first scheme, designed in part for students in regular courses, but chiefly for "the far more numerous class who may be expected to resort to its lecture rooms for such useful knowledge of scientific principles as they can acquire without methodical study, and in hours not occupied by active labor." In this last conception only (and some features naturally dependent on it) lay the seed of failure. It was promptly eliminated. The troublous days of the war prevented any further overt steps being taken until October, 1864, but when the "Scope and Plan" of that year appeared not a trace of the royal-road-to-a-little-knowledge conception remained. We shall not sketch the revised plan with the same particularity as we have the first one, for the simple reason that it is in all essentials the school as it stands to-day, and many of its details will better appear in our comparative summaries of certain facts, but in its main features it was as follows:

The school was "to provide a complete course of instruction and training, suited to the various practical professions of the mechanician ('mechanical engineer' then had an affected and unfamiliar sound), the civil engineer, the builder and architect, the mining engineer, and the practical chemist." It was also to furnish special training for any related industrial pursuits, as it has done and does do to some extent. Special stress was laid on thorough laboratory instruction in physics, mechanics, chemistry, metallurgy and mining, each student doing his own work for himself, and not merely standing by to see it done. To meet the needs of those in training as teachers and others, a general course in science was added to the scheme. The same six courses of instruction, carried on in all essential respects as Prof. Rogers suggested, remain the principal courses to this day, but five other courses have since been added, viz., one in natural history (1871), physics (1873), electrical engineering (1882), chemical engineering (1888), and sanitary engineering (1889). The relative importance of these several courses will appear later. We may note, however, that here as elsewhere mechanical and electrical engineering are rapidly growing in importance.

In introducing general laboratories for the instruction of individual students both in physics and chemistry the M. I. T. took a great step in advance. It proved a decided success in every way. The trouble and expense was not so much greater as had been expected, and the result was even more satisfactory than was hoped. The example has been very extensively followed, so that it is now no novelty. In 1876 extensive workshops were introduced by President John D. Runkle, in further extension of Prof. Rogers' original conception, and as an effect of the exhibit of the Russian technical schools at the Centennial. To further utilize these shops a subsidiary "School of the Mechanical Arts" was organized for artisans, but they are in active use for the engineering courses.

The interesting question now arises: How was the money for all this work obtained? Chiefly from tuition fees and public subscriptions, partially from state aid and individual bequests. To complete the first (Regus) building which now stands on the books at $315,000, the state gave the land only, on condition that $100,000 and the cost of the building should be secured by the Institute, which was done by public subscriptions. The state gave (in 1887-8) $100,000 clear and $100,000 conditional on the founding of 20 free scholarships and on the raising of another $100,000 by subscription, which was done. Some 12 years after President Rogers' death in 1870, a movement for a "Wm. B. Rogers Memorial Fund" of $250,000 was started, and also completed by subscription among the friends of the school. In all, nearly $1,400,000 has been given by private citizens, mostly by small subscriptions. The largest single gift was a bequest of Mr. Richard Perkins in 1886 of $100,000, and the next largest a gift of $50,000 from Mr. Geo. B. Dorr in 1890. Dr. Wm. J. Walker and Ralph Huntington left some needed bequests in the early days of the school, which were used for buildings. The school has always been pinched for money, and at the present time, out of its total revenue of $240,000, just three-quarters, or $180,000, is derived from students' fees. The percentage has often been still larger. The remaining $60,000 is in part ($5,640) from the State Agricultural Fund (proceeds of one-third of the sum realized from the Agricultural College land grant, which Massachusetts managed very badly), in part ($6,700) from sale at nearly cost of laboratory supplies and printed notes; in part ($3,441 last year) by small inroads on capital when needed, and the remainder (about $45,000 only) from interest on invested funds, rents, and some trifling miscellaneous sources. So late as 1888 the income from invested funds was only $25,000. The president's report well says: "Such a dependence of a college of the first rank upon tuition fees is altogether unknown among the educational institutions of the United States. Many institutions, with only one-half or one-third our number of students, have twice or thrice the amount of our permanent funds!"

The Institute now has, in round numbers, $800,000 invested in five buildings, with $40,000 more of equipment in them, and has about $525,000 in addition of invested funds, of which nearly half is the Wm. B. Rogers Memorial Fund. Besides the larger gifts already named, there are 15 other small funds bearing the names of individuals, ranging from $5,000 to $25,000. In the main, however, the invested funds have come from multitudes of small subscriptions, made possible only by an earnest and general interest in the work for which the M. I. T. was founded.

Such a record is quite without parallel. It is one of the most honorable pages in the history of Boston and of Massachusetts. It goes without saying that, however much credit one man may deserve as the soul of the whole project in the formation period, dozens and hundreds, not to say thousands, must have given earnest and persistent effort. It is impossible to read the story without feeling encouraged at such a splendid display of public spirit; without saying to oneself: "Well done, good and faithful servants." The state and the public will in the end add also: "Ye have been faithful over a few things; we will make you ruler over many things." The Massachusetts Institute of Technology may never have a superfluity of means, but until the spirit of its management has changed it will never be permitted to languish for lack of money.

* The Institute has a certain financial and other connection with the Lowell School of Design, but it is not an intimate one.

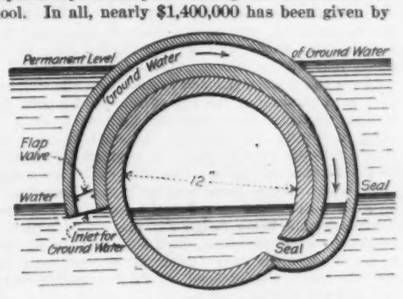


Fig. 2. Ground Water Conduit With Pipe Sewer.

A NEW DEVICE FOR CITY SUB-SOIL DRAINAGE.

The two accompanying cuts show very clearly the working of a "ground water conduit," just patented by Mr. Stephen E. Babcock, C. E., Chief Engineer of the water-works of Little Falls, N. Y.

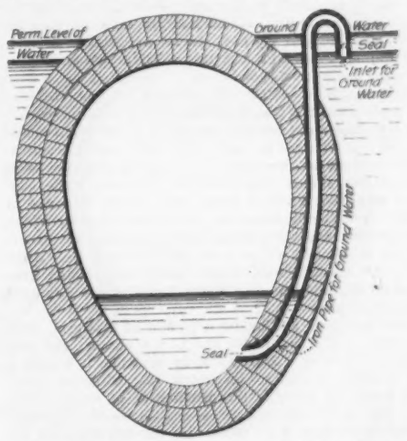


Fig. 1. Ground Water Conduit With Brick Sewer.

Fig. 1 shows the device applied to an egg-shaped brick sewer, and Fig. 2 to an ordinary pipe sewer.

The device is designed to keep the ground water at a permanent level or at one varying between fixed limits. The water seals shown in the drawings are designed to prevent gases from passing into the soil, and the flap valve to prevent the discharge of sewage into the ground.

The devices are placed right and left, alternately, so as to drain the ground each side of the sewer more perfectly. They are placed as near together as local conditions seem to require.

This method of removing ground or sub-soil water is held to be superior to tile drains with open joints or any other method where the passages for the water to enter the pipe are liable to be stopped with earth, or where earth may enter the pipe and clog it.

All things taken into account, it is not quite clear to us how this device can make a specially good record in service, as there are certain difficulties and disadvantages which at first sight seem serious. Still, experience might disprove some of these at least. Mr. Babcock is a well known hydraulic engineer, and has, doubtless, studied the pros and cons of his device with much more care than we, and for certain places and sewers it may prove to have a legitimate and useful field. The fundamental difficulty besides that of expense would seem to be the uncertain action of the flap valve.

THE IRON WHARF AT FORT MONROE, VA.*

The iron wharf at Fort Monroe, Va., was built in 1888-89, and is located on the site of the old wooden wharf, at the terminus of the roadway passing in front of the Hygeia Hotel. It is built on hollow cylindrical cast iron disk and screw piles (the latter having wooden bearing piles), spaced 14 ft. c. to c. in each direction, and braced by two systems of horizontal bracing of steel and wrought iron. The floor beams, resting on the piles, are steel I-beams, and the floor joists and planking are of pine. The floor is 7 ft. 11 ins. above low tide, and its area is about 63,500 sq. ft. A fender

* Abstract of a paper by Mr. John W. Dunklee, read at the annual convention of the American Society of Civil Engineers, June, 1892.

system of wooden piles and lumber surrounds the outer faces of the wharf.

The wharf extends from the shore in a southerly direction to a depth of 20 ft. at low tide on the edge of the channel of Hampton Roads. The extreme length from the shore is 332 ft. The width at the shore and for a distance of 42 ft. is 56 ft., increasing to 258 ft. at a distance of 154 ft. from the shore, and the outer corners are cut off diagonally, so that the width along the channel front is 154 ft. These diagonals have a frontage of 59 ft., and were planned in this manner to facilitate the landing of steamboats during adverse conditions of the wind and tide.

It was at first proposed to build the wharf on wrought iron piles with cast iron disks, similar to those used in the construction of the Coney Island and other ocean piers along the coast. Upon making borings at the site, however, it was found that near the outer limit of the wharf area, in depths of 20 ft. at low tide, the stratum of sand was but 5 ft. thick, while below this, mud was found to a depth of 50 ft. or more below low tide. While the thickness of the stratum of sand gradually increases as the water shoals, it was not regarded as affording a sufficient or safe bearing for disk piles, outside the 10-ft. curve, particularly in view of the mud beneath and the shifting bottom above. It was, therefore, decided to use in depths of more than 10 ft. a hollow screw pile, resting on and encasing a wooden bearing pile, previously driven and cut from 3 to 4 ft. above the bottom. Owing to the required shape of the iron piles the use of wrought iron was impracticable, and cast iron was therefore adopted. In depths of 10 ft. or less a cast iron disk pile was used. The cast iron was close grained, hard, white metal, intended to be without combined carbon, and of a character which would best resist the action of salt water, not excessively brittle and which would satisfactorily bear drilling. All castings were coated inside and outside with coal pitch and oil, by the Angus Smith process, as used for water pipe.

The disk piles are hollow cylinders of cast iron, with a diameter of 8 ins. inside and 10 ins. outside, the iron being 1 in. thick. At the foot of each pile is a disk 3 ft. in diameter and 1.5 ins. thick, cast with and forming a part of the pile, the distribution of weight from the pile to the disk being secured by means of eight brackets or ribs, 1 in. thick. On the underside of the disk is a 2-in. nozzle, cast with four 1-in. ribs. At the top of the pile is a circular flange or cap 2 ft. diameter and 1.5 ins. thick, cast with four ribs or brackets 1.5 ins. thick on the under side. The thickness of the iron of the pile is 1.5 ins. for a distance of 12 ins. below this cap. To the cap the floor beams and upper bracing are secured. Piles intended for depths of 7 to 10 ft., and which, if cast in one piece, would exceed 20 ft. in length, were cast in two sections with flanges 20 ins. diameter and 1.5 ins. thick. Each flange has a circular opening through the center, 8 ins. diameter (being a continuation of the inner surface of the pile cylinder), and is provided with eight brackets 1-in. thick. Bolt holes were drilled through the flanges, and in both disk and screw piles the abutting surfaces of the flanges were planed and the two sections bolted together with wrought iron bolts, red lead being used to make a tight joint. Eight 1 or 1¼-in. bolts were used in bolting the sections together, and all bolts were painted with two coats of iron ore paint before being used.

In the center of the cap of each two-section disk pile is a circular opening 4 ins. diameter. In the one-section disk piles this opening is made 8 ins. in diameter to permit the removal of the core bar. The disk piles were sunk by means of the water jet without special difficulty, except where logs or piles were encountered. The disks are about 6 ft. in the sand.

The screw piles were generally cast in three sections. The lower section, which rests on and encases the wooden bearing pile, is 8 ft. long, 13 ins. interior diameter, and 1 in. thick. At the top of this section is a flange 24 ins. diameter and 1.5 ins. thick, provided with eight supporting brackets, and in the center of this flange is a 4-in. circular opening. About 1 foot above the lower end of this section of pile are two screw-pile blades, with a maximum diameter of 32 ins. The blades are 2.5 ins. thick at the junction with the pile, and ⅝-in. at the edge of the blade. The middle thickness and section is 8 ins. diameter, and has a similar lower flange with a 4-in. opening, corresponding to the opening in the upper flange of the lower section. The upper end of the middle section is provided with a circular flange 20 ins. diameter and 1.5 ins. thick, with eight brackets 1 in. thick and having an 8-in. opening in the center, the full inner diameter of the pile. The variations in the depth of water were provided for by varying the lengths of the middle section by multiples of 1 ft., the length ranging from 7 to 17 ft. The upper section of the pile is similar to the middle, with a flange on the lower end 20 ins. exterior and 8 ins. interior diameter and 1.5 ins. thick. The top of the upper section has a flange or cap 24 ins. in diameter and 1.5 ins. thick to receive the steel floor beams and upper bracing, as with the disk piles. The upper sections are all 6 ft. 9 ins. long. On piles other than those to which the lower system of bracing is attached, the upper and middle sections are cast in one piece, where the length of such combined section does not exceed 20 ft.

The wooden bearing piles were of pine, creosoted with 12 lbs. of coal tar creosoting oil per cu. ft. They were 10 ins. diameter at the smaller end, and the portion of the pile to be encased by the iron screw pile was worked down so as to be 12 ins. in diameter and perfectly straight. The length of pile to be so covered after the pile had been driven and cut off was 8 ft. It was necessary that the piles should be driven exactly 14 ft. c. to c., and perfectly true to line. The use of a floating pile driver was therefore inadmissible, and a land pile driver was used, supported on a false work of temporary piles and stringers, the temporary piles being afterward withdrawn. The bearing piles were driven to a refusal equivalent to 1 in. for a hammer weighing 2,200 lbs. and falling 15 ft. The length of pile required was generally 50 to 60 ft., and the length in the ground ranged usually from 20 to 30 ft. Each pile was cut off by a circular saw at the proper depth to receive the cast iron pile, this being about 4 ft. above the bottom of the bay. The sections composing the screw pile having been bolted together, the iron pile was carefully lowered and set in place over the wooden pile, until the lower or screw section rested on the sand. Wooden levers were then attached to the cap and the pile screwed down into the sand until the flange at the top of the lower section came to a firm bearing on the top of the wooden pile. It was found that during this operation the sand worked up between the wooden pile and the inside of the iron pile, and, accumulating at the top of the wooden pile, prevented the flange from reaching its true bearing. In order to obviate this difficulty, the water jet was employed to force out the sand. To prevent the corrosion of the interior of the piles by salt water, they were filled with concrete composed of 1 part Portland cement, 2 parts sand and 3 parts pebbles. The opening through the lower flange was first closed with neat Portland cement placed in small bags and forced down so as to cover the hole. After the cement paste had set, the water was pumped out of the interior of the pile and the concrete put in.

The floor beams are 12-in. steel I-beams, weighing 56.5 lbs. per ft., in lengths ranging usually from 14 to 28 ft. They were laid parallel to the longitudinal center line of the wharf in order that, acting as struts, they might better resist and distribute the shocks coming against the outer face of the wharf, which it was assumed would be the greatest to be resisted.

Beyond the distance of 126 ft. from the shore the steel beams are secured to the caps of the piles by means of four ⅝-in. bent wrought iron plates, two on each side of the beam; each pair secured to the beam by four 1¼-in. bolts, and each plate secured to the cap by two 1¼-in. bolts. At joints the beams were connected by two ⅝-in. fish plates and four 1¼-in. bolts, passing through the webs. All joints came on the centers of piles and, as a rule, adjacent beams break joint by a panel length of 14 ft.

The upper system of bracing extends over the entire wharf. The tops of the piles are connected by 8-in. steel I-beams weighing 30 lbs. per ft. laid at right angles to the floor beams. These beams abut against webs of the 12-in. floor beams and are secured to the caps of the iron piles by plates and bolts. The four piles forming the corners of a bay or square are connected by two 1¼-in. round wrought diagonal tie rods with eyes, attached to the caps of the piles with 1¼-in. bolts. Each rod has a turnbuckle. Midway of the bay a transverse 7-in. steel I-beam weighing 25 lbs. per ft., connects and gives lateral support to the webs of the floor beams, the connection being similar to that of the 8-in. beams. On the south front and the diagonal corners of the wharf 12-in. steel I-beams replace the 8-in. beams, and form the iron front of the wharf. In order to resist the severe strains and shocks coming aginst these corners additional iron piles have been put in, and diagonal 12-in. I-beam struts used in place of the tie rods. Oak struts are used for two panel lengths from the shore.

The I-beam form of strut was adopted as best meeting all the requirements of the case both as to limited area of exposed surface and facility of connection with the iron piles and floor beams. All wrought iron was thoroughly painted with iron ore paint. The system of lower bracing is put in on the three outer bays (attaching to four rows of piles), on the sides of the wharf, and on the five outer bays (attaching to six rows of piles) on the south end of the wharf. The system consists of longitudinal and tranverse lines of iron struts, weighing 16.15 lbs. per ft., and diagonal 1¼-in. round tie rods (with turnbuckles), all bolted to the lower flanges of the upper section of the piles. On the bays near the diagonal corners, where extra iron plates are placed, diagonal struts are substituted for ties.

The floor joists are of 4×14-in. heart pine lumber laid transversely, resting on and notched down 2 ins. over the steel floor beams. They are spaced 2 ft. apart, c. to c., and on the outer bents are secured to the floor beams by wrought iron straps to prevent lifting from the action of the wind and waves during storms. Near the south face of the wharf the joists are 8×14 ins. and spaced 3 ft., c. to c. The planking is 3-in. heart pine plank laid at right angles to the joists and spiked thereto with 6-in. cut spikes. All floor joists have 2×3-in. cross-bridging at intervals of 4 ft.

To prevent injury to the iron piles from the striking of steamers against the wharf while making landings, a wooden fender system or extension, about 10 ft. in width, was built around the five most exposed faces of the wharf. It consists of creosoted pine piles driven about 10 ft. apart, and on lines 10 ft. from the faces of the wharf, with a 12×12-in. oak cap drift-bolted to the piles. Floor joists of 4×14-in. pine lumber rest on this cap and extend back to the main wharf, the space being floored over with 3-in. plank. Directly above the cap a 12×12-in. oak back log is placed, projecting 3 ins. above the wharf, bolted down through the cap with 1-in. bolts. Along the face of the wooden extension are bolted two 10×12-in. oak fender timbers, the lower bolted to the cap and the upper to the back log with 1-in. bolts spaced 2 ft. apart. Inner fender timbers from 12×12 to 12×16 ins. are bolted to the face of the iron wharf proper, to protect the iron work in case a steamer cuts its way through the outer fender.

The fender piles are of oak, driven in groups of three at intervals of about 20 ft. long the outer front of the fender system, bolted together and to the caps with 1-in. bolts, also secured from movement by 8×8-in. oak "chocks." At the six salient angles of the wharf larger groups of about 15 fender piles each were driven and bound together by means of 1-in. galvanized wire rope. These large groups are intended to resist the great stress resulting from the partial turning of a steamer against the wharf. Sixteen mooring piles are driven at convenient points near the outer edge of the wharf and braced to the wooden floor system.

At the shore end of the wharf a bulkhead was built of a continuous row of wooden piles capped with a 12×12-in. pine timber, the cap being drift-bolted to each pile by 1-in. square drift bolts, each 2 ft. long. The filling behind the bulkhead is sand.

There is a building 98×42 ft. on the wharf, and the middle third, 32 ft. 8 ins. long, has two wings facing east and west, each projecting 10 ft. A canopy 10 ft. wide extends from these central wings around the south end of the building. This building provides two store rooms 41 ft. 6 ins. × 32 ft. and 32 ft. × 62 ft., two waiting rooms 20 × 20 ft. and two office rooms 11×20 ft. The framing is of Virginia pine and the roof trusses of Georgia pine, wrought iron being used for tension rods. The exterior rough sheathing is of Virginia pine and the siding of cypress. The waiting-rooms and offices are finished in Georgia pine and provided with fire-places.

The quantities of material, etc., used in the construction of the wharf (not including the building), and the contract prices for the work complete were as follows:

Cast iron piles, number...	331	
Cast iron piles, weight....	1,287,079 lbs.	4½ cts. per lb.
Wrought iron and steel.	749,340 lbs.	5 cts. per lb.
Creosoted wooden piles.	368	{ $22, $24 and $30 each.
Fender piles, number.....	180	$10 each.
Mooring piles, number....	16	$10 each.
Pine lumber.....	385,793 ft. B. M.	$33 per M.
Oak lumber.....	30,124 ft. B. M.	$42 per M.
Bulkhead.....	151½ lin. ft.	

The cost of the wharf, exclusive of the building, was $121,306.41; the contract price for the building was $7,439.67; and the total cost (exclusive of engineering and contingencies) was $128,746.

The work was under the charge of Lieut.-Col. Peter C. Hains, U. S. Engineers, and Mr. John B. Dunklee was the principal assistant engineer on this and other work in Colonel Hains' charge. The inspector of construction was Mr. James Ware. The contract for the wharf proper was let to the Groton Bridge & Mfg. Co., of Groton, N. Y., and for the wharf building to Dorden & Ashe, of Hampton, Va.

THE TITAN CRANE AT LEIXOES, PORTUGAL.

In constructing the jetties for the port of Leixoes, near Oporto, Portugal, Messrs. Duparchy & Bartisal, the contractors, used the crane described and illustrated in "Le Genie Civil" of March 26, 1892, from which journal the following account is taken:

With this machine concrete blocks weighing 50 tons were placed at a distance of 95 ft. from the center of rotation, and smaller blocks aggregating 15 tons, in carriages of the same weight, were placed 144.3 ft. from the same point. The revolving portion of the crane has a total length of 225.5 ft., with

what may be called a jib 150.8 ft. long. The two braced girders forming the moving part of the crane are 6.56 ft. apart on centers, 18 ft. deep at the center, 2.62 ft. deep at the end of the jib and 10.17 ft. deep at the rear end. The top chords of the jib are 30 ins. wide and carry the track for the carriage carrying the load. The counter weight on the inner end of the crane is masonry resting upon a strong metal floor.

The turntable is supported on a strong carriage and revolves upon a double circular track 30.18 ft. in diameter. The four beams supporting the turntable are 4.6 ft. deep and 34.1 ft. long on the side, to which are riveted the legs of the carriage. The two circular tracks are 2.3 ft. apart on centers and the rails are trapezoidal in form, 2 ins. high and 6.4 ins. wide. These tracks are carried on circular beams securely tied to the outer frame and braced against torsion. The cast steel wheels are each 32 ins. in diameter, 7.2-in. wide on the flange, and are arranged in four groups of four wheels each, mounted in forged steel frames in such manner as to assure a distribution of the load. Each pair of wheels has its own beam, and the two beams in one group carry a third beam which articulates with a casting firmly fixed to the revolving part of the crane.

The wheels under the carriage, for running the crane in and out, are arranged in eight groups of fours and coupled together as described above.

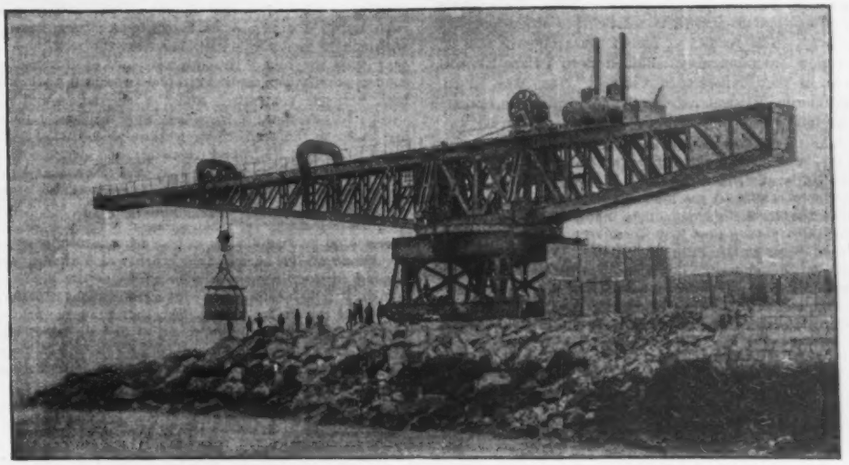


FIG. 1. VIEW OF TITAN CRANE, LEIXOES, PORTUGAL.

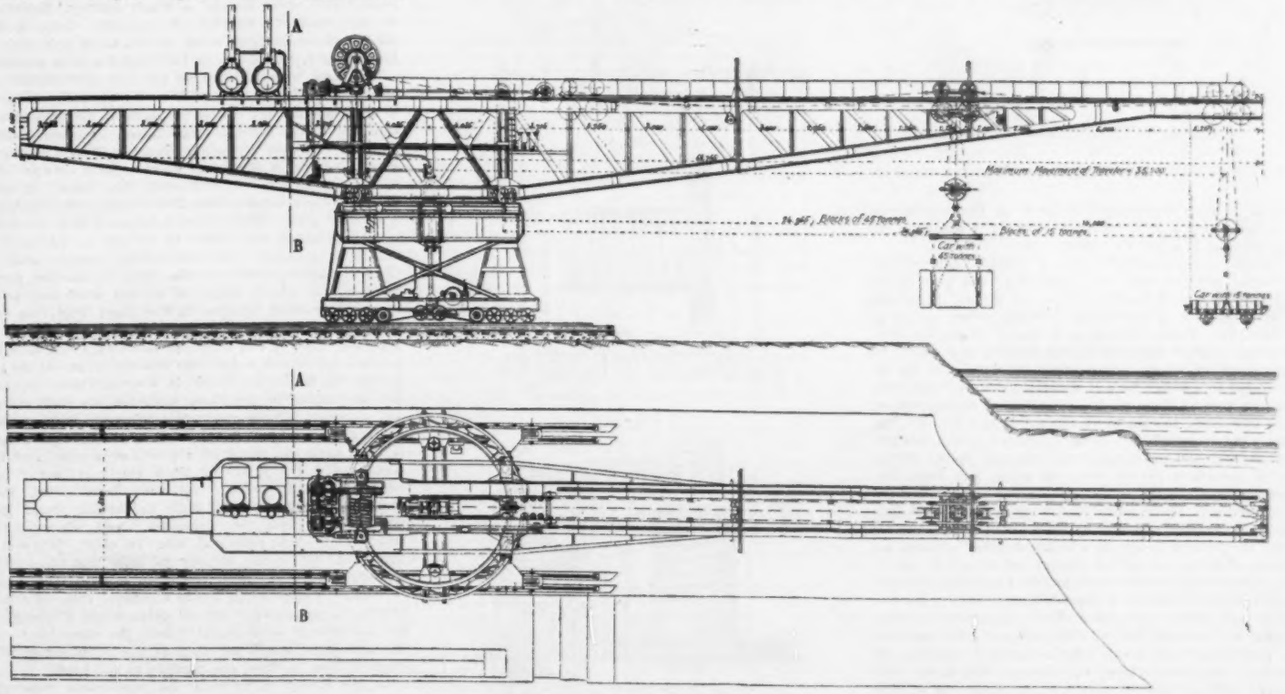


FIG. 2. ELEVATION AND PLAN OF TITAN CRANE AT PORT OF LEIXOES, PORTUGAL.

Each wheel is 2.8 ft. in diameter and 5.4 ins. wide on the rim. These wheels are operated by linked belts run by a small engine carried on the frame of the carriage. These wheels are cast iron with a steel tire, and the balanced mounting operates advantageously in overcoming any inequalities in the track.

The main motor and mechanism for turning the crane and hoisting and moving the load is located upon the upper part of the crane itself. The engine has two 11.2-in. cylinders with 20 ins. stroke, and is about 30 HP. All the handling of the load is done by intermediary conical friction gear with all the levers under the control of a single operator. The large chain drum for lifting is operated directly by an endless screw gearing into a wheel fixed to the end of the drum and provided with helicoidal teeth. The moving of the load on the girders is accomplished by means of two linked belts, attached to the carriage and passing over two return pinions, one at the end of the jib and the other near the motor. Both the mechanism for lifting and moving the load is geared to two speeds, in the proportion of 1 to 2½, and used as required for handling the 50-ton or the 30-ton loads.

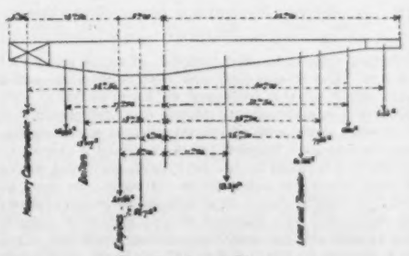


Fig. 7. Load Diagram.

The carriage for the load is made of wrought iron and has four cast steel wheels, each 34 ins. in diameter. The pulleys of the lifting chain are 4.1 ft. in diameter, with steel axles and bronze bearings. The carriages upon which the blocks are carried to the crane are handled by a steam capstan operated by a special engine placed upon the inner side of the main rolling carriage.

In handling the loads the engine makes about 50 revolutions per minute, though this is increased to 80 revolutions without load. The following rates of speed for the several movements are given, with 50-ton blocks:

Raising the load 7 ins. above the ground	30 secs.
Lowering to a depth of 25.3 ft.	550 "
Raising the hook, empty	250 "
Hooking and unhooking	150 "
Total time, 16m. 20s.	980 secs.

The movement of the load back and forward and the turning of the crane consumes about the same time as it does to raise the empty hook, as follows for 50-ton loads:

Lifting 7 ins. above the ground	10 secs.
Shifting load forward 93.4 ft.	95 "
Discharging	5 "
Return of empty carriage	50 "
Lowering carriage on jetty	40 "
Hooking and unhooking	40 "
Total time, 4m.	240 secs.

Recent explosions of gas in St. Louis sewers near the river front have been found to be not due to leaking gas mains, but to gas generated from decaying matter in the sewers and prevented from escaping by the high water in the river.

ELECTRICITY AS A MODE OF MOTION.

The impetus which has been given to the modern industrial arts by the practical application of electricity bids fair to be rivaled by the impetus given to physical science through investigations of electricity and magnetism and their relations to other forms of energy. The results of recent researches in this direction are admirably summed up by Prince Kropotkin in the "Nineteenth Century" for May in an article on "Recent Science," from which we extract the following:

The interest awakened some three years ago by the novel and startling experiments in electricity made by the Karlsruhe Professor Hertz is still maintained. They not only confirmed the long since suspected connection between electricity, magnetism, light, and radiant heat; they also gave a new impulse to speculations as to the structure of matter altogether, and the modes of transmission of energy. Numerous works on these subjects, all more or less connected with the Karlsruhe researches, are continually appearing, and in order to appreciate them we are bound to revert to the starting-

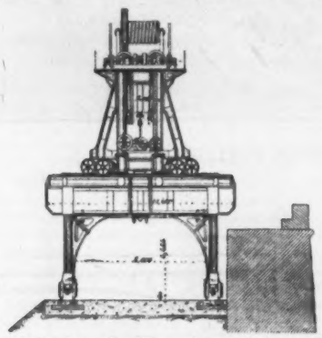


Fig. 3. Section AB; Titan Crane, Leixoes, Portugal

point—Hertz's experiments themselves. The best means for mastering a new branch of science, it has been remarked, is to study its nascent state.

When a moving body—say, a billiard ball—strikes another body at rest, and, imparting to it part of its energy, sets it in motion; when the waves, originated on the surface of a pond by a falling stone, spread in wider and wider circles, and finally begin to rock a piece of wood that was quietly floating in a corner of the pond; or when a tuning-fork communicates its vibrations to another fork at a certain distance—we may not be able to trace all the complicated movements of the two balls, the water of the pond, and the air; but our mind is satisfied to some extent as to the manner of transmission of energy from one ball to the other, from the stone to the piece of wood, and from the sounding-fork to the other fork. Again, when light or radiant heat is transmitted through the interstellar space, or through the vacuum obtained in a glass tube—that is, through space in which we detect almost no traces of ponderous matter (matter acted upon by gravitation)—we explain the transmission of the luminous and heat energy by making a plausible supposition; we assume that besides the matter which constitutes the solid, liquid and gaseous bodies, there is some other matter, or rather some other still more attenuated condition of matter, inseparable from the former, which we call ether; and we assume that the displacements of the particles of ether (vibrations, or, maybe, other changes of state) are the medium for the transmission of luminous and heat energy. It was quite natural, therefore, to suppose—and it was supposed—that the transmission of electro-magnetic disturbances is effected in the same way; that they also produce vibrations, or some other changes in the usual conditions of the particles of the surrounding ether; and that these changes, or vibrations, are transmitted in all directions from one particle of ether to the next, at some measurable speed—the speed of transmission probably being not much different from the speed of transmission of light and radiant heat, which is about 180,000 miles in a second.

However probable this hypothesis, physicists had hitherto failed to confirm it. Maxwell advocated it chiefly on theoretical grounds, but decisive experiments were wanted; and although Siemens had once measured the speed of transmission of electricity, and found it not very different from that of light, (a) his measurements were still considered as uncertain. Now came Hertz with his ingenious experiments. He applied a method which had proved most useful in studying sound. When a tuning-fork is set vibrating, its vibrations alternately condense and rarefy the surrounding air and both rarefactions and condensations are transmitted by the air in all directions; we may call them, by analogy, waves. Now, if these waves meet anywhere a reflecting board, they are sent back, in the same way as the waves of the sea are reflected by the wall of a quay. But they may be sent back so that each reflected condensation meets on its back journey with a new condensation coming from the fork, and in that case the sound is reinforced; or, each reflected condensation meets with a rarefaction, and in this case both actions neutralize each other—the sound is weakened. So that, if we slowly approach our reflecting board to the fork, there will be places where the board reinforces the sound (condensations meeting with condensations), then weakens it, and then makes it louder again, although the board is moved all the time in one direction, toward the tuning-fork.

Of course, things are not so easy with electricity. There is no great difficulty in producing alternate electrifications of the surrounding ether which would correspond to the alternate condensations of the air, but they must follow each other with a tremendous rapidity. In fact, if the tuning-fork makes, say, 1,000 vibrations in the second—the speed of sound in dry air being but 1,100 ft. in the same time—a condensation will only have traveled little over one foot before a new con-

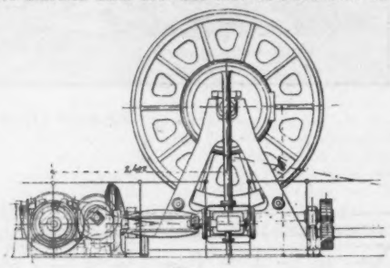


Fig. 4.

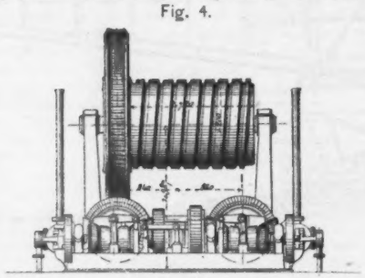


Fig. 5.

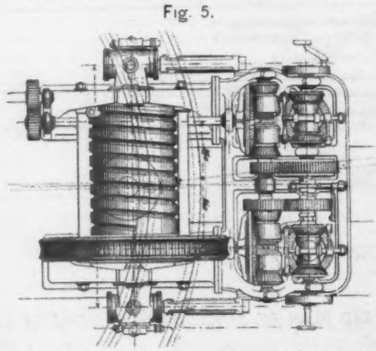


Fig. 6. Moving Machinery; Titan Crane, Leixoes, Portugal.

densation follows it. The "waves" of sound will be 1.1 ft. long. But if our electrical charges also succeeded each other with a frequency of no more than 1,000 discharges in a second, the electric wave (supposing that it spreads at the rate of 180,000 miles in a second, like light) would have traveled 180 miles before a new wave would be originated by the next discharge. And waves of that length are not easy to deal with. So that, in order to obtain waves of a reasonable length—following each other at a distance of say, 33 or 40 ft.—Hertz had to produce discharges alternating 30,000,000 times in a second. (b) So he did. He obtained such rapid discharges for very short intervals of time, and thus he could measure the distances at which the electrical waves followed each other. A reflecting board, and some means of detecting the loops and nodes,' i. e., the places where the waves reinforce or extinguish each other, were the next requisites.

A reflecting board was readily made out of a sheet of zinc, 10 to 12 ft. square. As to the "detector," Hertz chose, out of the various means at his disposal, a brass wire, provided with two knobs and bent into a ring, which could give sparks when it received electric waves of a certain length. (c) With these three instruments—the vibrator, the screen, and the detector—the experiments could be carried on, and they proved at once the close connection existing between the phenomena of electricity and light.

As soon as sparking began in the vibrator, and the detector was approached to it, sparks began to jerk between the knobs of the latter; but they disappeared as soon as the screen was interposed between the two—the "waves" being interrupted in this case. On the contrary, when the screen was placed immediately behind the detector, strong sparking followed; if it was removed about 18 ft., the sparking ceased—the direct and the reflected waves extinguishing each other; but when the screen was moved away for another 18 ft., sparking reappeared—the two waves reinforcing each other, and so on. In short, the phenomena were exactly like those which would be noticed if a tuning-fork, a reflecting board, and a resonator were used. It was thus proved that each electrical discharge produces some disturbance in the surrounding space; that the disturbance is transmitted, through the "non-conductive" air, exactly as luminous or sound vibrations are transmitted; and that electricity is propagated, like heat and light, at some finite and measurable speed. Of course it would not be possible to give here the tedious processes by which the measurements were made, nor to tell the difficulties, the doubts, and the seemingly contradictory facts which were met with in the way; although dating from yesterday "Hertz's experiments" have already a whole history. Suffice it to say, that the velocity of electricity, both in the air and the conductive wires, proved to be very near to that of light, namely about 180,000 miles in a second.

This may be considered as the first part of the experiments. The second part is even more interesting, as it disclosed further analogies between electro-magnetism and light. Light is transmitted by some bodies, and is reflected by other bodies. Electro-magnetic waves behave in the same way; a plate of zinc acts upon them as a mirror and sends them back, but they pass through a wooden door just as light passes through a window plate. Hertz could send them into the next room through a shut door. If we put a red-hot iron ball in the focus of a parabolic mirror, we may make it light a match adjusted in the focus of another parabolic mirror which is placed at the other end of a room. Electricity behaves in the same way; we can send beams of electrical oscillations by means of a parabolic mirror, and intercept them at a distance by another mirror and send them into its focus. If we interrupt the initial discharges in a certain way—as they are interrupted in the Morse alphabet—we shall transmit electrical signals and have a telegraph without connecting wires. Light is refracted by transparent bodies if they have the shape of a prism or a lens; and by means of a big prism of pitch Hertz refracted the electro-magnetic "rays;" he could bend them, and send them under a right angle to another room. Reflected light can be polarized, and electro-magnetic "rays" are polarized, too. In short, Maxwell's hypothesis as to the identity of light and electricity is fully confirmed. Both are disturbances (vibrations, or whatever they might be) in the usual state of ether which are transmitted like all other kinds of energy—like the energy, of the billiard ball, the stone, and the tuning-fork, of which we spoke at the beginning of this chapter, that is, from one particle to the next.

So we finally part with the mysterious "electric fluid," just as we parted, thirty years ago, with the "caloric fluid," and we simply have before us a separate mode of energy. When the waves of ether have lengths of from $\frac{1}{1000000}$ to $\frac{1}{700000}$ parts of an inch, we have chemical energy; when they follow each other at distances of from $\frac{1}{700000}$ to $\frac{1}{36000}$ parts of the inch, our eyes see them as light; when they grow to $\frac{1}{18000}$ parts of the inch, we see them no more, but we feel

(a) 200,000 to 280,000 kilos. in a second; the velocity of light being about 300,000 kilos.

(b) 30,000,000 times 35 ft. would make 180,000 miles.

(c) To attain a very rapid succession of alternate electrifications, Hertz used two brass plates, 12 ins. square, to each of which was attached a thick wire, about 2 ins. long, terminated by a brass knob. The distance between the two knobs was very small—less than 0.1 in. When the plates were electrified by an induction coil, a series of sparks jerked from one knob to the other, the change rapidly passing forward and backward and giving very rapidly alternate discharges. This was the "vibrator." As to the "detector," or "resonator," it consisted of a thick wire, the two ends of which were provided with brass knobs, and the length of which was taken so as to suit the oscillations in the vibrators. The wire being bent into a circle, its two knobs were brought very near to each other, so as to show sparks at the reception of the feeblest electric wave. (Sitzungsberichte der Berliner Acad. der Wissenschaften," Feb. 9, 1888). It hardly needs adding that during the experiments the reflecting board, or the apparatus used instead, remained stationary, and that the resonator was moved instead of it. For more details see an excellent resume in the last chapter of Th. Preston's "Theory of Light," London 1890. The general reader may consult the very good papers in "Nature," March 5 and 14, 1890.

them as radiant heat; and when they attain lengths which are measured by yards and miles, they give the electrical phenomena.

A wide series of researches was evidently called into life by these researches, and, in fact, nearly all that is now written upon electricity is in some way connected with them. First of all, it was necessary to verify the experiments; and so they were verified by several physicists—in this country by Professor Fitzgerald and Fr. Trutton at Dublin, (d) and by Professor Lodge and Mr. Dragoumis at Liverpool. (e) In fact, Professor Lodge had nearly discovered the same phenomena simultaneously with Hertz, as he was making in 1887 and 1888 his experiments on the rapid discharges obtained from Leyden jars. (f) Blondlot, in France, slightly modifying the primitive experiments, finally settled the velocity of electricity in the air at from 291,000 to 304,000 kilos. in the second, thus very nearly approaching to the velocities of light. (g) Then, Hertz himself having been brought by his earlier measurements to admit that the speed of electrical disturbances is much smaller in wires than in the surrounding air, more careful measurements were required, and they were made in Geneva and in Germany, and proved that the velocity, as foreseen by theory, is equal in both cases. (h)

Another important matter was to study the magnetic part of the same electric disturbances. In Maxwell's theory the magnetic disturbances ought to be nothing but transversed rotations of the particles of ether in a plane perpendicular to the line of transmission of light and electricity—"molecular vortices," as he used to say, (i) and Hertz succeeded in proving by a new series of experiments—or, at least, in rendering it most probable—that the magnetic force obeys in its transmission the same laws as electricity, but that the direction of its vibrations is perpendicular to the line of transmission of the electric waves; and he made at the same time an attempt at measuring the mechanical effects of the electric disturbances. (j)

At the same time a further confirmation of the light theory of electricity was given by Arons and Rubens, who proved that the relation which, according to Maxwell, ought to exist between the isolating power of various substances and their powers of refracting the rays of light, exists in reality. The resistance offered to the passage of light and that offered to the passage of electricity are connected by a simple relation. (k) On the other side, Sir William Thomson read before the Royal Society a most interesting paper on the screens, and their efficiency against waves of different lengths. He demonstrated that if the electric sparks have a frequency of four or five per second, a clean white paper screen is sufficient to stop them; but when the frequency of the sparks is 50, or more, the white paper screen makes no perceptible difference. If the paper is thoroughly blackened with ink on both sides, some moderate frequency of a few hundreds per second is, no doubt, sufficient to practically annul the effect of the interposition of the screen. For discharges following each other with frequencies up to 1,000 millions in a second, a screen of blackened paper is perfectly transparent, "but if we raise the frequency to 500 million millions, the influence to be transmitted is light, and the blackened paper becomes an almost perfect screen." As to the wonderful electric effects produced by means of currents alternating with very high frequency, such as those produced by the Montenegrin professor, Nikola Tesla, the readers of this Review have already been familiarized with them in a preceding number. (See Eng. News, July, 18, 1891.)

Many more researches—some of them mathematical and highly suggestive as regards the very structure of matter, (m) and some others opening new fields for experimental work, like J. J. Thomson's researches into the speed of propagation of the luminous discharge of electricity through a rarefied gas, (n) and Hertz's new experiments upon the transmission of the same discharges through various screens, transparent or not for light (o)—might be mentioned in connection with the above. But we must say, at least, a few words about the quite new lines of research indicated by Mr. Crookes' experiments on what he names "electrical evaporation." It was already known that an induction current, when passing through the platinum electrodes of a vacuum tube, tears off the molecules of platinum from the sphere of attraction of the wire, and transports them to a certain distance. Now, Mr. Crookes, comparing these phenomena with those of evaporation of liquids, made various experiments in order to determine the "evaporating" power of the electric stress under different circumstances and with different substances. He caused water to be transported in this way by the electric current; in order to increase the power of electricity upon metals, he diminished the cohesion of their molecules by heating the metals; and he studied also the relations between the transport of the molecules by electric stress, and the phenomena of phosphorescence (p). One feels, especially when remembering the speculations of the first half of this century (chiefly those of Seguin), that a new and most promising field is opened by these researches; they raise a host of questions relative to the most difficult parts of molecular mechanics.

The same must be said as regards modern research in chemistry. The work now done is of two different kinds. While a numerous army of laboratory workers accumulate heaps and heaps of minute facts, and study the properties of separate chemical compounds without being guided by any general idea, a few chemists devote themselves to the most intricate questions relative to the very substance of chemical reactions and molecular structure. They endeavor to bridge over the gulf between molecular physics and chemistry, and to conceive the latter as a separate branch of physics and mechanics.

(d) "Nature," Vol. xxxix., p. 391, Vol. xli., p. 205.
(e) Ibid. Vol. xxxix. p. 548.
(f) Professor Lodge writes, in the "Proceedings of the Royal Society," (Vol. 1, 302, August 28, 1891): "This same discovery (Hertz's) would have been made by the audience at the Royal Institution on the evening of March 8, 1889, if it had not been made before; for, during a lecture on Leyden jars, every time one was discharged through a considerable length of wire, the heavily gilt wall paper sparkled brightly, by reason of the incident radiation."
(g) "Comtes Rendus," 1891, t. 112, p. 1,058; t. 113, p. 628.
(h) Sarasin et L. de la Rive in "Comptes Rendus," 1891, t. 112, Nos. 12 et 13; Rubens and Ritter in Wiedemann's "Annalen der Physic," 1890, Vol.. xl.
(i) See section 822 of Maxwell's "Treatise on Electricity and Magnetism," second edition, 1881.
(j) "Uber die mechanischen Wirkungen electrischer Drahtwellen," in Weidemann's "Annalen der Physik," 1891, Vol. xlii., p. 405. Ritter and Rubens in same periodical, Vol. xl., 1890. MM. Sarasin and De la Rive having come to the conclusion that the vibrators sent out a great number of undulations of various periods, new researches were undertaken by Bjerkness ("Archives des Sciences physiques et naturelles," 1891, t. 27, p. 229), and they brought to light the so-called "dampening" of electrical undulations—a question which also was discussed mathematically by Poincare ("Archives," t. 25, p. 609), and Perot ("Comptes Rendus," January 25, 1892).
(k) All the gases, many liquids, and many solids (glass, gutta-percha, etc.)—all named dielectrics—offer a great resistance to the passage of electricity. A considerable expenditure of work is required for the passage of electricity, and the relative amounts of this expenditure in various bodies are measured by the so-called "dielectric constants." These constants, in Maxwell's theory, must be equal to the squares of the indices of refraction of light. This prevision has now proved to be true for paraffin in three different states, glass, resin oil, olive oil, xylol, and petroleum. "Annalen der Physik," 1891 and 1892, Vols. xlii. and xliv.
(l) "Proceedings of the Royal Society," April 1, 1891, Vol. xlix., p. 418.

(m) "On some Test Cases for the Maxwell-Boltzmann Doctrine Regarding Distribution of Energy," by Sir William Thompson, in "Proceedings of the Royal Society," Vol. L., No. 302, p. 79.
(n) "Philosophical Magazine," 1890, Vol. xxix.; "Proceedings of the Royal Society," January 15, 1891.
(o) "Annalen der Physik," 1892, Bd. 45, p. 28.
(p) "Proceedings of the Royal Society," Vol. l. p. 87.

The Liverpool docks are to be given a greater depth over the sills, in consequence of the successful work of dredging at the Mersey Bar, and the increasing sizes of ocean steamers. With sills 20 ft. 6 ins. below datum, the level proposed, there will be a depth of 36 ft. at high water of mean tide, and 29 ft. 1 in. at lowest high water of neap tides, so that, providing a channel to deep water can be maintained at this level, an enormous advantage will be gained for the large ocean steamers, which are now obliged to complete their loading in the river, as they cannot leave their dock fully laden and cross the bar on the same tide. The following is from the "Engineer," of London:

The depth on the bar has been increased to 14 ft. to 18 ft. at low water. Encouraged by this, and no doubt alarmed also at the still increasing size of ships, and the knowledge that the competition of the Manchester Ship Canal has to be met, the dock committee, after consultation with shipbuilders and shipowners, has recommended that the river entrance to the Huskisson group should be increased from 80 ft. to 100 ft. in width, and the sill lowered 2 ft. to 20 ft. 6 ins. This will provide a sill 9 ft. 6 ins. lower than any sill yet laid in the Mersey, with the exception of the Eastham Lock sills at the entrance of the Manchester Ship Canal. These are 23 ft. below Old Dock Sill, but the company's power to dredge the approach channel was limited by Parliament to 20 ft. below Old Dock Sill, so that the Dock Board Sills will be 6 ins. below the statutory depth of this channel.

The subsidiary works providing internal access to the surrounding docks have also been widened from 80 ft. to 90 ft., and the second river entrance, 80 ft. width, is to be lowered from 18 ft. 6 ins. to 20 ft. 6 ins. It is also proposed to increase the dimensions of the graving dock to be built on the site of the 45 ft. Huskisson dock from 650 ft. by 80 ft. to 710 ft. by 90 ft., and to lay the sill 10 ft. below Old Dock Sill. The estimated increase in expenditure is $900,000, and the Board thereby hopes to provide for vessels 700 ft. in length and 65 ft. beam. It was mentioned at the meeting that the most "beamy" ship afloat, a man-of-war, was 71 ft., and that the new Cunard liners would be 65 ft. This latter dimension is only 2 ft. more than the "City of New York," which measures 525 ft. by 63 ft., while the "City of Rome" reaches 560 ft. in length, with a beam of only 52 ft. 3 ins. It therefore seems quite possible that the capacity of an entrance 100 ft. wide, leading into the tideway of the Mersey, may be taxed to the uttermost when passing a long ship in heavy weather. The Liverpool side is the lee side, and the entrances at the north end are exposed, the storm gates of the Canada Dock having been carried away during a gale in 1868.

It is interesting to observe a return to the wide dock entrance designed 30 to 40 years ago by the late Mr. Jesse Hartley for the Canada Dock. This was before the paddle wheel was discarded for the screw propeller, and when the Cunard Commodore Judkins and the "Scotia" side-wheel (Atlantic liner) were very much to the front. The northern entrance to Birkenhead Dock was also made 100 ft. wide during the same period. The docks at the north end of Liverpool built between 1870-80, on which $15,000,000 were expended, have main entrances 65 ft. wide and intermediate gates 50 ft. wide.

A method of enabling locomotives to haul trains up steep grades is being brought out by Pocock & Co., of London. A grooved drum is keyed on the driving axle of the engine and a stationary cable is passed round the drum by a double turn. The cable is anchored at each end, and kept in position on curves by means of pulleys. Some years ago another English firm brought out an engine for heavy grades, in which a drum carrying a wire cable was carried under the rear end of the engine. At the foot of the grade the engine was uncoupled and the end of the cable attached to the train. The engine then ascended the grade alone, and at the summit was anchored to the track by means of clamps, and the drum then driven by separate cylinder, hauling the train up by the cable.

The only items in the River and Harbor bill on which the House and Senate cannot agree are the Senate provisions for the boat railway at the Dalles of the Columbia River (illustrated in our issue of Sept. 12, 1891,) and for a ship canal from Lake Washington to Puget Sound. A conference committee is considering these items.

Oatmeal water is well known to be an excellent beverage for men engaged in hard work, especially in hot weather, and this was served out to the men engaged on the recent change of gage from 7 ft. to 4 ft. 8½ ins. on the Great Western Ry., of England. An English contemporary says that the sustaining power of beer in hot weather or in cold is out of all proportion to that of such a beverage, cool, refreshing and thirst-quenching as oatmeal water. The drink was made in buckets holding about 2½ gallons. In each bucket was placed two pints of oatmeal, and mixed thoroughly with warm water to the consistency of cream. Then boiling water was added until the bucket was filled. After stirring the mixture it was left to cool.

The Railway Safety Appliances bill reported favorably to the House of Representatives by the Committee on Interstate Commerce requires the completion of the equipment of freight cars with continuous brakes and automatic couplers by July, 1898. A standard coupler is to be selected by vote of the railways, 75% of the votes cast being necessary to a choice. The vote is to be taken in July, 1893, and after July, 1895, all new cars or cars sent to shop for repairs must be equipped with automatic couplers and continuous brakes. The equipment of locomotives with power brakes is made compulsory after July, 1893, and the equipment must be completed by July, 1895. The bill reported by the Senate committee some weeks ago provided merely for a more thorough investigation of the question.

A bicycle relay run between Indianapolis, Ind., and Columbus, O., a distance of a little less than 200 miles, was made at an average speed from start to finish of a mile in 3 min. 27½ sec., or 17.35 miles per hour.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

MOHAWK & MALONE.—The Herkimer, Newport & Poland Ry. Co., the Herkimer, New York & Poland Extension Ry. Co., and the Adirondack & St. Lawrence Ry. Co., have been consolidated under the above name. The consolidation is for 500 years and the principal offices will be at New York City. The officers of the new company are: Pres., W. Seward Webb; Vice-Pres., James W. Husted; Treas., Frank G. Smith, and Secy., Charles H. Burnett. The route of this railway, which is now well advanced toward completion, was given in detail in our issue of June 9.

COLUMBUS, LIMA & MILWAUKEE.—The application for an injunction restraining the new directors of this company from resuming work on its proposed railway has been refused. It is now stated that work will be resumed on the partly graded section between Lima and Defiance, O., in 90 days. Pres., Hyias Sabine, Marysville, O.

BANGOR & AROOSTOOK.—The contractors for building the 10-mile section of this railway southwest from Houlton, Me., as noted last week, are Stewart, McCabe & Quinn, of Canada. Work has been begun with a small force which will be largely increased in a few days. The contract price was $12,000 per mile. Ch. Engr., Moses Burpee, Houlton, Me.

PENNSYLVANIA.—The extension of the Chestnut Hill branch to the Trenton Cut-off near Ft. Washington, Pa., is being rapidly graded. The line will be about six miles long and will be double tracked.

WILKESBARRE & EASTERN.—E. S. Moorman & Co., of Lynchburg, Va., have a contract for grading 20 miles of this Pennsylvania railway.

TOLEDO, WALHONDING VALLEY & OHIO.—A correspondent writes us that the section of this line between Coshocton and Loudonville, O., 46 miles, will be graded by Aug. 1. Tracklaying began May 1, and about 15 miles have now been laid. It is expected to have the line opened for traffic by Oct. 1. The work is heavy; maximum grade 21 ft. per mile. Ch. Engr., J. C. Hanlon, Coshocton, O.

CHICAGO & WEST MICHIGAN.—Ch. Engr., J. J. McVean, Grand Rapids, Mich., writes us that tracklaying is completed on the extension to Petoskey City and Bay View, Mich. The line, including the 9-mile branch to Elk Rapids, Mich., is 88.3 miles long. There is one draw-bridge 215 ft. long at Charlevoix, Mich. The work was in charge of H. F. Northrup, Div. Engr., Traverse City, Mich.

BATIMORE & OHIO.—A large force is now at work ballasting the branch from Wooster to Lodi, O., built last year, and it is stated that an examination of the route for a proposed extension south is being made.

Projects and Surveys.

BINGHAMTON & STATE LINE.—At a meeting of the directors of this company held June 18, the following officers were elected: Pres., Jos. P. Noyes; Vice-Pres., W. Scott Brandt; Secy., E. E. Katteli; Treas., H. C. Ross. Joseph K. Noyes was appointed Ch. Engr., and Charles U. Sherman, of Binghamton, N. Y., Locating Engr. Surveys will begin at once.

EASTERN CENTRAL.—Surveys have been begun for this proposed railway from Galion, O., toward Bowerstown, O. The object of the road is to provide a short east and west line through the Ohio coal fields. Pres. Daniel Babst, Jr., Crestline, O.; Ch. Engr., R. H. Lee, Loudonville, O.

CHICAGO, INDIANAPOLIS & CHATTANOOGA SOUTHERN.—At a meeting of the directors of this company recently held the preliminary arrangements were completed for beginning work. A press dispatch quotes F. L. Patrick, the chief promoter, as saying that construction would begin by July 15, and that 98 miles of the line between Owensboro, Ky., and Mitchell, Ind., would be completed by Dec. 25. As soon as the work is begun south of Mitchell the line between that place and Indianapolis, Ind., will be located. A press dispatch says: "The line from Owensboro, Ky., to Mitchell is decided upon, and the right of way secured, the distance being 93 miles. Between Owensboro and Mitchell it will pass through the following towns: Rockport, Grand View, Fulda, St. Meinrad, Ferdinand, Celestine, Centerville, French Lick, West Baden and Orleans. On this 93 miles $156,000 of subsidies has been voted, and it is understood that Owensboro, which will be one of its best stations aside from Indianapolis, will give a subsidy of $100,000. Twenty-five miles of the road passes through the best block coal of Indiana, the vein ranging from 4½ ft. to 6 ft. in depth, and it opens up territory to the furniture, the desk, the wagon, the stave and heading companies, which is second to none in quality of hardwood lumber. North of Mitchell the line has not been fully decided on part of the distance, but will run through Nashville, giving Brown Co., which now has no railroad, a first-class road to the capital. Although, for some miles the road pases through a hilly country, the highest grade will be but 62 ft. to the mile, which is lighter than either the Ohio & Mississippi or the Louisville, New Albany & Chicago can boast of in Southern Indiana."

PHILADELPHIA & CAPE MAY.—A press dispatch contains the following information concerning this projected road noted last week: "A new railroad company, which will erect a line between Philadelphia and Cape May, N. J., is being organized, and the subscriptions to stock are being received on condition that no money is to be paid in until the line is finished. The road is to be operated by the Philadelphia & Reading R. R. Co., which will connect with it at Landisville, Cumberland Co., N. J. From this point the road will run south down the bay side of Cape May County to Cape May. The road will be 76 miles long and is said to be backed by John C. Bullett and Thos. Robb, of Philadelphia, who owns large properties at Cape May."

LONG ISLAND (NEW YORK).—It is rumored that a railway company has been organized to build lines of railway on Long Island to compete with the present Long Island R. R. Co. No details are given.

INDIANAPOLIS, LOGANSPORT & CHICAGO.—At the recent annual meeting of the directors of this company reports were presented showing encouraging progress made in securing the right of way and financial aid. An officer is reported as saying that construction would begin within 30 days. Ch. Engr., Walter G. Osmer, Logansport, Ind.

YORK SPRINGS & DILLSBURG.—This company, whose incorporation was noted in our last issue, proposes to build a railway from York Springs, Adams Co., Pa., to Dillsburg, York Co., Pa., 9 miles, using the abandoned roadbed of an old railway between those places. Pres., Thos. G. Neely, York Springs, Pa.

Southern.—Existing Roads.

JACKSONVILLE, ST. AUGUSTINE & HALIFAX RIVER.—The contract for the extension from Daytona to New Smyrna, Fla., has been let to Matthew Hays, of Daytona, Fla., and T. L. Marquis, of Bartow, Fla. Work is now in progress.

SAVANNAH, FLORIDA & WESTERN.—A press dispatch gives the following details of a proposed railway alliance which will involve considerable new construction: "H. M. Flagler, of New York, and H. B. Plant, president of the Plant system of railways and steamships, have formed a close alliance by which, it is said, they hope to control all the Florida railway business. Mr. Flagler is extending his lines from St. Augustine down the eastern coast to New Smyrna and down the Indian River to Rock Ledge. He will also cut across the country from New Smyrna to Sanford, where he will connect with the South Florida R. R. to Tampa. The South Florida road is a part of the Plant system. This will give Mr. Flagler and Mr. Plant a continuous line from Charleston, S. C., to Savannah, Jacksonville, St. Augustine and Sanford to Tampa, making it the trunk line of Florida. On the west coast Mr. Plant has been paralelling the Florida Southern R. R. He also shuts it out by his connecting link, the South Florida, between Pemberton Ferry and Bartow. He is extremely likely to continue paralelling it from Pemberton to High Springs, where he strikes the Savannah, Florida & Western R. R., with its eastern and western connections. When he has finished that he has a through Florida system without a single gap, and with connections with the eastern coast lines for business by way of Jacksonville. But President Coleman, of the Jacksonville, Tampa & Key West R. R., it is said, has made a deal with the South Bound Co. to extend its lines from Savannah to Jacksonville, thus giving him a northern outlet. Next week a surveying party of nearly 50 men will be put to work laying out the line from Jacksonville to Savannah. The party is supposed to be put in the field by President Coleman."

BRISTOL, ELIZABETHTON & NORTH CAROLINA.—Tracklaying has been completed from Bristol, Tenn., to Bluff City, Tenn., 11 miles, and a large force is now at work between Bluff City and Elizabethton, Tenn., 10½ miles. It is expected that tracklaying will be completed to Elizabethton by July 20. Ch. Engr., Geo. S. Bruce, Bristol, Tenn.

GEORGIA, CAROLINA & NORTHERN.—This company is securing the right of way for a belt line around the city of Atlanta, Ga., and it is stated that construction will soon begin. The line will be about 8 miles long.

Projects and Surveys.

SOUTHWESTERN.—This company has been chartered in Florida to build a railway from Green Cove Springs to Micanopy, Fla., 60 miles. Among the incorporators are D. N. Reynolds, of Jacksonville, Fla., and W. J. Wilson, of Green Cove Springs, Fla.

FRANKFORT & ALTON.—Surveys are in progress for a railway from Frankfort to Alton, Ky., 9 miles. James McHugh, of Frankfort, Ky., is in charge of the surveys.

OWENSBORO & WEST LOUISVILLE.—A preliminary survey has been made for a railway from Owensboro to West Louisville, Ky., and it is stated that capitalists have offered to build the line if the right of way is granted. The survey was made by Nat. Alsop, of Owensboro, Ky.

PENSACOLA & NORTHWESTERN.—This company which proposes to build a railway from Pensacola, Fla., to Memphis, Tenn., has been chartered in Florida, with S. N. Van Pragg, President.

COVINGTON & OCMULGEE.—This company has been organized to build a railway in Georgia. Pres., Joel Kitchens; Sec., Harry Camp, and Treas., Edward Heard.

TITUSVILLE & INDIAN RIVER.—Chartered in Florida to build a railway from Titusville to Cape Florida, with branches to Cape Canaveral and New Smyrna. The incorporators are Warren C. Spencer, Boston, Mass., and Burton K. Barrs and Albert W. Webber, of Jacksonville, Fla.

Northwest.—Existing Roads.

CHICAGO & GREAT WESTERN.—At a meeting of the stockholders of this company recently held it was decided to issue $10,000,000 of new capital stock. The proceeds are to be used principally in improving the road, and purchasing new equipment.

DULUTH, SOUTH SHORE & ATLANTIC.—It is stated that construction will begin soon on the extension from Iron River, Wis., to Duluth, Minn., about 40 miles. The company has heretofore used the tracks of the Northern Pacific R. R. between those two points, but the contract has expired and it is stated that it cannot be renewed on suitable terms.—Local papers state that arrangements are about completed for the construction of a branch from Sanborn to Ashland, Wis., about 12 miles.

YANKTON, NORFOLK & NORTHWESTERN.—M. W. Larson & Co., who have the contract for grading 30 miles of this work as noted last week are making arrangements to begin work at once. The road is projected to run from Yankton, S. Dak., to Norfolk, Neb., and the projectors expect to have it completed this year. The towns along the route have raised a bonus of $150,000 in aid of the road. Newman W. Gifford, of Chicago, Ill., is at the head of the enterprise.

DULUTH, PIERRE & BLACK HILLS.—At a recent meeting the directors of this company directed the balance of the grade between Aberdeen and Pierre, S. Dak., to be finished at once and ordered the remainder of the right of way to be secured. It is stated that contracts for the grading will soon be let. The road is projected to run from Oakes, N. Dak., to Pierre, S. Dak., 181 miles. Ch. Engr., B. P. Tilden, Aberdeen, S. Dak.

GREAT NORTHERN.—C. H. Jenks, of Larimore, N. Dak., Supt. Dakota Division of this road, is reported as saying that it is the intention of this company to build a line from Grand Forks, Minn., to Duluth, Minn.

Projects and Surveys.

MARINETTE & WESTERN.—It is announced that the projectors have secured sufficient financial backing to warrant them in beginning the construction of this road from Marinette to Abbottsford, Wis., 160 miles. Pres., Jesse Spaulding, Chicago, Ill. Secy., G. W. Henly, Marinette, Wis.

Southwest.—Existing Roads.

ST. LOUIS TERMINAL R. R. ASSOC.—The bids for the stonework of the Union Passenger station have been rejected and new bids will be asked for.

Projects and Surveys.

GALVESTON, HOUSTON & KANSAS CITY.—Chartered in Texas to build a railway from Galveston to Virginia Point, Tex., 16 miles. Among the directors are Walter Gresham and M. C. McLemore, of Galveston.

CALVERT & HEARNE.—The citizens of Calvert, Tex., are making efforts to secure the construction of a railway from that place to Hearne, Tex., to connect with the International & Great Northern Ry.

Rocky Mt. and Pacific.—Existing Roads.

SANTE FE, PRESCOTT & PHOENIX.—Grading is now in progress as far as Banghart's ranch, 40 miles south of Ash Fork, Ariz., and about one-half of the grading on this section is completed. From Banghart's ranch to Prescott there will be a large amount of rock work. The engineers are now locating the line between Prescott and Phoenix, Ariz., and construction will begin as soon as the section between Prescott and Ash Fork is completed. The work will be very heavy.

PORTLAND & MT. SCOTT.—This 4-mile railway from Portland, Ore., to the foot of Mt. Scott, has been completed.

EVERETT & MONTE CHRISTO.—About 1,800 men are now at work on this line from Everett, Wash., to the Monte Christo mines. The work is very difficult, including six tunnels from 300 ft. to 800 ft. long.

UNION PACIFIC.—It is announced that work will begin at once on a 10-mile extension of the Maxwell branch to timber lands.

SOUTHERN PACIFIC.—The 14-mile branch from Calles to Fresno, Cal., has been completed.

Projects and Surveys.

AMERICAN CENTRAL.—This company has been chartered in California to build a railway from San Francisco to Boise City, Idaho, with a branch from some point in California to Klamath Falls, Ore. The principal offices are at Junction City, Ore. Pres., Cyrus Baldridge; Sec. and Treas., C. W. Lamson.

SEATTLE & EVERETT.—This company is now securing the right of way for its proposed railway. The road will ultimately run from Seattle to Everett, Wash., but for the present it will be constructed to a point about eight miles north of Seattle to townsites owned by the North Seattle Co., a branch of the Guarantee Loan Co., of Minneapolis, Minn.

CANADA & WESTERN.—Press dispatches give the route if this proposed railway as from Victoria, B. C., on Vancouver Island, north via Nanimo to the Seymour Narrows, and thence to the mainland and east to a connection with some line paralleling the Canadian Pacific Ry. The company has been granted a bonus of 20,000 acres of land per mile of road by the Canadian Government. J. S. Conlican is the chief promoter of the road.

SIUSLAW & EASTERN.—The entire cash subsidy of $100,000 asked by this company has been raised, and in addition right of way privileges valued at $90,000 have been secured. By the conditions of the subsidy work must commence before July 1, and the road completed within two years. The road is projected to run from Siuslaw Harbor to Eugene, Ore., 50 miles. Pres., Geo. H. Elisbury, Eugene, Ore.

SAN FRANCISCO & ATLANTIC.—This company has been organized by Fred Homer and others, of Oakland, Cal., to build a railway from Oakland to Los Angeles, Cal., 500 miles, passing through Stockton and along the east side of the San Joaquin Valley. It is stated that the company has secured control of the surveys of the old Stockton, Fresno & Southern R. R. from Stockton to Visalia, and that surveys have been made from Stockton to Oakland. Eastern capitalists are reported to be backing the enterprise, which is stated to have no connection with the California Midland R. R., now under survey from Stockton to Bakersfield, Cal.

Foreign.

MEXICAN NORTHERN PACIFIC.—This company, for the construction of whose road contracts have been let to Huss, Townsend & Co., of Chicago, was organized some years ago, under the name of the Sonora, Sinoloa & Chihuahua Ry. Co. in Mexico, and the name of the Deming, Sierra Madre & Pacific Ry. Co. in the United States. The road as projected was to run from Deming, N. Mex., south to Guerro, Mexico, with branches east to Chihuahua and west to Guaymas, on the Gulf of California, and thence to Topolobampo Bay, a total estimated length of 1,500 miles, and the Mexican Government granted the company a subsidy of $13,000 per mile and 2,500,000 acres of land. The greater portion of the line between Deming and Chihuahua was surveyed more or less completely in 1888 and 1889, and the contract for construction let to Elliott, Huss & Co., of Chicago, Ill. Some 30 miles were partly graded from Deming south, and a small amount of work done at both Guaymas and Chihuahua, and work was then suspended. In 1891 the promoters interested English capital in the enterprise and reorganized the company under the name given above. Contracts for resuming work were recently awarded to Huss, Townsend & Co., and they have already established headquarters at Deming, N. M., and will begin construction at once.

PANOCHA & SANTA BARBARA.—The people of the town of Santa Barbara, in the State of Tamaulipas, Mexico, are agitating the construction of a railway from La Panocha, on the Monterey & Mexican Gulf Ry., and that place via Xicotencatl, Quintero, Antiguo and Nuevo Morelos.

ELECTRIC RAILWAYS.

MIDDLETOWN, CONN.—The Schuyler Electric Co. wishes to acquire the horse railway and equip it for electric traction. Pres., C. E. Dunstin.

BROOKLYN, N. Y.—The Brooklyn City Ry. Co., has let a contract for a three-story car and repair shop 700 × 200 ft., to cost $200,000. It will have six miles of tracks and will hold 800 cars. This will be for the new electric equipment. The company will vote July 26 on the increase of its capital stock from $6,000,000 to $12,000,000 to pay for the change to electric traction.

BUFFALO, N. Y.—The Buffalo Ry. Co. is building a single track electric extension.

BEAVER FALLS, PA.—The Riverview Electric Street Ry. Co. has been organized, with a capital stock of $50,000. Pres., E. L. Hutchinson.

RICHMOND, VA.—The Richmond & Seven Pines Ry. is to be equipped and operated by the Richmond Railway & Electric Co.

TORONTO, ONT.—The Toronto & Scarboro Electric Ry. & Light Co. has been authorized to build an electric line on the Kingston road between the eastern city limits and the county boundary.

ELEVATED RAILWAYS.

BROOKLYN, N. Y.—The Kings County Elevated Ry. will build a line to Coney Island.

BALTIMORE, MD.—The Lake Roland Elevated Ry. Co. has awarded a contract to the Pennsylvania Steel Co. for building its elevated structure; also for a 400-ft. viaduct, making nearly two miles of elevated track. The General Electric Co. has the contract for electrical equipment.

HORSE AND MOTOR RAILWAYS.

MONTCLAIR, N. J.—The Township Committee will probably adopt the report of the Citizens' Committee containing recommendations of certain provisions to be included in all street railway franchises.

CHESTER, PA.—The Chester, Darby & Philadelphia Ry. Co. proposes to build a line from Chester to Darby; capital stock, $50,000. Pres., Geo. C. Hetzel, Ridley Park, Pa.

DICKSON, PA.—The Blakely & Dickson Traction Street Ry. has been incorporated; capital stock, $36,000. Pres., Wm. Walker, Mayfield, Pa.

ALBANY, ORE.—The motor line is to be extended two miles, and a new engine has been ordered.

CORVALLIS, ORE.—A motor line is proposed to connect Corvallis, Brownesville, Crawfordsville, and Halsey. Committees have been appointed by the Councils of these towns to consult and take measures for a preliminary survey.

HIGHWAYS.

NEW JERSEY.—Proposals for the construction of stone roads in the townships of Cinnaminson, Chester, Mount Laurel, Beverly and Willingboro will be received July 7 by the Board of Freeholders of Burlington County, at Mount Holly, N. J. The Engineers are E. G. Harrison, Moorestown, N. J., and Charles Stokes, Beverly, N. J. The Board of Freeholders will also be petitioned to build one mile of stone road at Mount Holly. The Middlesex County Board of Freeholders have appropriated $20,000 for improvement of roads.

BRIDGES, TUNNELS AND CANALS.

LONDON, ONT.—At a meeting of the Council Mr. Calvert instructed the commissioner to build a bridge between Metcalf and Ekfred. A bridge is also to be erected between Caradoc and Adelain. The report of the Special Committee on Bridges was adopted. The piers and abutments are to be rebuilt and raised 6 ft. and an iron bridge of two spans placed thereon. The bridge committee has under consideration the construction of several bridges to replace those washed away by the flood.

PORTLAND, ME.—It is proposed to erect a bridge to cost $4,000 at State St.

HAVERHILL, MASS.—The Rocks bridge has been closed to public travel owing to its unsafe condition. Mayor Burnham will take steps to have it rebuilt.

NEW HAVEN, CONN.—The $2,000 appropriation for building of Webster St. bridge has been transferred to the appropriation made for the DeWitt St. bridge and work will be begun in a short time. Judge Pickett and Alderman Keane may be addressed.

PLAINFIELD, CONN.—A new iron bridge is to be constructed to span the Pequabuck River on the New York & New England R. R. The bridge is to be constructed so as to admit of a double track.

COLTON, N. Y.—At a special town meeting it was voted to raise $5,000 to build an iron bridge across Racket River at this place to replace the wooden bridge, which is considered unsafe.

HAMILTON, N. J.—The Board of Freeholders has ordered a new bridge to be built across Assanpink River near the line of Hamilton and Lawrence townships.

PORT ORAM, N. J.—The committee, W. E. King, Geo. Pierson and James M. Frost, has met the Board of Freeholders and has decided to build a new iron bridge over the canal.

SUMMIT, N. J.—A committee of three has been appointed to take into consideration the building of a bridge over a stream on Williamson Ave., Union Township, ascertain cost, and report to board. A committee was also appointed to examine a bridge near the village of New Providence and report at the next meeting of Board the necessity for and probable cost of a new bridge.

WOODBURY, N. J.—The new structure to be built over Woodbury Creek will cost $10,000 and will be of iron with stone foundations.

WILMINGTON, DEL.—Proposals will be received until July 5 for all labor and material, and constructing complete an iron highway bridge over White Clay Creek near Thompson Station, and also for abutments and wing walls for same. Bids may be made for both bridge and masonry complete or for either. Plans may be seen at Court House. Paul Gillis, Chairman.

ELKTON, MD.—The Co. Comrs. will receive bids for both iron and wooden bridges to decide which will be most advisable to take the place of the old bridge over the Bohemian River and come within their appropriation of $20,000.

STOCKDALE, PA.—The Comrs. have decided to rebuild iron bridge at this place. The bridge will be 14 ft. longer, making 114 ft. between the masonry.

CLEVELAND, O.—The Cleveland, Canton & Southern R. R. Co. is considering plans for an iron swing bridge at this place to replace a wooden bridge in the upper flats. H. A. Blood, Gen. Mgr., Boston, Mass.

COLUMBUS, O.—Bids will be received until July 21 for constructing a bridge over Walnut Creek in Hamilton Township. The bridge will be a through span Baltimore truss 252 ft. span c. to c., 33 ft. high c. to c., with a 20-ft. roadway. Bids will also be received for 10,500 cu. yds. of fill, 1,040 cu. yds. of broken stone or gravel, 116 perch of concrete, 1,486 cu. yds. of dry excavation, 200 cu. yds. of back filling and 325 perch of sandstone masonry. Co. Aud., Henry J. Caren.

HAMILTON, O.—Engineer Weaver has been ordered to make plans for an iron bridge across Carl's Creek

EAU CLAIRE, WIS.—Plans are being prepared for a viaduct 120 ft. over the railway tracks at this place. The viaduct will be of steel trestle work, with the exception of one 58-ft. girder span. Bids for construction will be received on July 6. Cy. Engr., C. A. Alderman.

MILWAUKEE, WIS.—$45,000 have been appropriated for an iron bridge over Kinnickinnic River at Clinton St.

DULUTH, MINN.—Sealed proposals will be received until July 2 by B. S. Dash, for the construction of bridges on line of First St. Plans on file at office of Patten & Frank, 612 Palladio Bldg., of Duluth.

OMAHA, NEB.—Bids will probably soon be asked for building an iron and steel viaduct on South Sixteenth St. The roadbed will be 50 ft. wide, with an 8-ft. sidewalk on each side. The estimated cost is $200,000.

WASHINGTON, KAN.—Bids will be received until July 7 for building the following bridges: An iron bridge across Mill Creek town of Morrow, an iron bridge across Coon Creek and a wooden bridge across North Coon Creek. N. B. Needham, County Clerk.

EUREKA, CAL.—Sealed proposals will be received until July 5 by Board of Supervisors of Humboldt Co. for the construction of a bridge across the North Fork of the river. Proposals will be received at same time and place for construction of a bridge across Mill Gulch. C. D. Stearn, Clk.

WATER-WORKS.

New England.

BELLOWS FALLS, VT.—Engr. Ellsworth, Holyoke, Mass., recommends the raising of the surface of Minard's Pond, the present supply, 10 ft., and bringing into it Farr and Ellis brooks, by 10 and 8-in. pipe lines 1 1-3 miles long. This will more than double the present watershed capacity; estimated cost, $14,000.

EAST HAMPTON, MASS.—Water Comrs. H. G. Knight, C. W. Smith and A. J. Fargo wish bids until July 5 for building a dam, gate house and pumping station. Engr., W. W. Strong, Northampton.

LOWELL, MASS.—Still further experimental wells will be sunk, this time by D. Andrews & Bro., Brooklyn, N. Y.

MARLBORO, MASS.—Cy. Engr. B. R. Felton informs us that the Legislature has authorized the city to take an additional supply from Millham Brook or Fort Meadow reservoir and to issue $150,000 of bonds. A new pumping station, 16-in. force main 2¼ miles long, and a storage reservoir will be required.

Middle.

HANCOCK, N. Y.—It is reported that a 3,000,000-gallon reservoir at an elevation of 170 ft. will be added.

HUNTINGTON, N. Y.—The Huntington Water Co. proposes to build works at once if enough water-takers can be secured to warrant such an action.

LIBERTY, N. Y.—It is reported that Chas. H. Smith, Middletown, is making surveys, and that $20,000 of 4½% bonds for works have been sold.

LOWVILLE, N. Y.—A renewed attempt to secure works is being made. Address Wood & Milligan.

OGDENSBURG, N. Y.—The Council has ordered the raising by taxes of $3,000 each for new mains and a new iron and wood suction pipe.

SYRACUSE, N. Y.—Bids for trenching and laying mains are wanted, as noted in our advertising columns.

WALDEN, N. Y.—It is reported that bids will be received by the village until July 6 for building works, including a pumping plant and four miles of mains. Clk. Comrs., E. A. Nichols; Engr., E. D. Smalley. A contract for boring wells has been awarded to E. C. Evans, Walden.

YONKERS, N. Y.—Bids will be received until July 7 for furnishing and delivering 625 tons of 24-in. A pipe; 200 tons of 24-in. B pipe; 65 tons of 20-in. A pipe; 50 tons of 12-in. A pipe; 20 tons of 8-in. A pipe; 30 tons of 6-in. pipe; and 40,000 tons special castings. R. Eichmeyer, Prest. Bd. Water Comrs.; J. C. Lockwood, Clk.

RIDGEWOOD, N. J.—Engineers and others interested in the construction of water-works and sewerage systems are invited to address the chairman of the Township Committee regarding proposed plants. Population estimated at nearly 3,000.

WESTFIELD, N. J.—At an informal election the people voted 57 in favor of accepting the proposal of the Union Water Co., of Plainfield, to build works o nthe franchise plan, and 241 in favor of issuing bonds for township works. The Township Committee has the power to act as it chooses in the matter, the election being merely of an advisory character. A late report states that the committee proposes to issue bonds and the opposition threatens an injunction suit.

CANTON, PA.—It is reported that James Herdic, Williamsport, has leased the plant of the Citizens' Water Co., and will build a storage reservoir on the mountains.

COCHRANTON, PA.—It is reported that surveys for works will be immediately made. It is proposed to construct a reservoir with a capacity of 1,000,000 gallons, water to be supplied from a spring 1½ miles from town.

COALPORT, PA.—The Coalport Water Co. has been incorporated; Directors, Samuel Hagarty, R. A. Holden and others; Treas., A. L. Hagarty; $2,000.

DUQUESNE, PA.—The newly incorporated Duquesne Water-Works Co. proposes to introduce water from the Monongahela River. Jas. S. Kuhn, McKeesport, J. H. Purdy, Pittsburg, and J. N. Cockburn, Allegheny, are interested.

HANOVER, PA.—The people will vote on issuing $60,000 of bonds and buy the works of the Hanover Water Co., and $40,000 for improvements to the plant.

EPHRATAH, PA.—It is reported that the Council is considering the building of works. A company built works in 1879.

JOHNSONBURG, PA.—It is reported that additional works will be built.

MIFFLINTOWN AND MILLERSBURG, Pa.—It is reported that the company which proposes to supply these boroughs has let contracts for the works and that construction will be started July 1 and completed by Nov. 1.

PITTSBURG, PA.—The issuance of $100,000 of 4% 20-year renewal water bonds to be dated July 1, 1892, has been authorized.

CAMBRIDGE, MD.—The people recently voted in favor of works.

Southern.

WESTON, W. VA.—Works are still wanted.

QUITMANN, GA.—The Town Council is considering the construction of works.

KEY WEST, FLA.—A proposal to grant a franchise for water-works and sewerage has been introduced and referred to a special committee consisting of Comrs. Monsalvatge, Sawyer and Johnson.

NICHOLASVILLE, KY.—It is reported that John A. Geary, Lexington, has received a franchise for works.

PARKLAND, KY.—A local company may build works.

North Central.

CELINA, O.—Works are talked of.

CINCINNATI, O.—The Mayor has appointed as members of the Water Commission Dr. T. W. Graydon, A. Howard Hinkle, J. W. Prendergast and Henry Haacke. On June 20 the people will decide by vote whether $6,000,000 shall be expended for new works under the direction of the Commission.

FINDLAY, O.—The Clerk has been authorized to advertise for the sale of $25,000 water bonds.

MADISONVILLE, O.—Bids will be received until July 16, for $15,000 of 4½%, 20-30-year village water bonds. Clk., Bennett Carter.

MARTIN'S FERRY, O.—Bids are wanted for a 2,000,000-gallon pumping engine. Address Water-Works, Chas. S. Moore, Supt.

COVINGTON, IND.—A 20-years' franchise has been granted to W. S. Reed & Co., Chicago, to establish and maintain works. This company has since formed the Covington Light & Power Co. There will be about 5 miles of 10 to 6-in. mains, and 40 hydrants. Water will be pumped to a stand-pipe.

LA GRANGE, IND.—A vote on the building of works will be taken.

MANISTIQUE, MICH.—Works are projected, the proposed supply, according to reports, being from Indian Lake, about three miles distant.

BELLEVILLE, ILL.—The City Water Co., it is reported, has secured a right of way for a pipe line from Lake Christine.

CHICAGO, ILL.—Bids will be received until July 5 for the construction of crib and shaft, constituting the shore intake for the 68th St. pumping station. J. Frank Aldrich, Comr. Pub. Wks.

CHICAGO, ILL.—Bids for laying mains on several streets will be received until July 5. J. Frank Aldrich, Comr. Pub. Wks.

MARSHFIELD, WIS.—The Council has granted a water and electric lighting franchise to W. H. Upham, Marshfield. The town reserves the right to buy the works within a year. Franchises have been granted to two outside companies in the past and been abandoned.

Northwestern.

PANORA, IA.—The town has bonded itself for works to the amount of $6,000.

COLERIDGE, NEB.—It is reported that a vote will be taken on the building of $5,000 works.

Southwestern.

ST. LOUIS, MO.—Bids will be received until July 5 for furnishing and erecting complete in place at the Chain of Rocks, gates, valves and iron work of the screen chamber, wet well and engine pits. Geo. Burnet, Pres. Bd. Pub. Impvts.

MANOR, TEX.—J. C. Harris is interested in a water-works project.

Pacific.

SOUTH BEND, WASH.—The South Bend Water Co. has let the contract for its reservoir and ordered its pipe. It will have a gravity supply. Secy. and Mgr., E. Shepard, Seattle.

LA GRANGE, ORE.—Cummings & Cooke will build the works here under their contract at once.

DELANO, CAL.—It is reported that a franchise for works in this town has been granted.

SAN LORENZO, CAL.—The San Lorenzo Water Co. has been incorporated by R. B. Miller, San Francisco, W. Knox, Haywards, S. B. McKee and others, Oakland; capital stock, $100,000, of which half has been paid in. Mr. Knox owning 480 of the 500 shares subscribed.

Canada.

NORTH SYDNEY, N. S.—Bids for building town works are wanted until July 2. Clk., J. N. Armstrong.

STELLARTON, N. S.—The Council has been instructed to build works.

IRRIGATION.

YAKIMA COUNTY, WASH.—The Tacoma & Yakima Land Co. is locating its ditch. Byron Barlow and E. C. Burlingame, Tacoma, are interested.

SAN DIEGO COUNTY, CAL.—Pres. Jones, of the Linda Vista Irrigation District, accompanied by Consult. Engr. Manuel and Surveyor Alverson, recently went to the Pamo Valley to make a complete survey of the dam site and flume line on which to base plans and specifications for construction.

NEW COMPANIES.—Southern Irrigation Co., Orlando, Fla.; C. W. Jacocks, C. J. Hicks and C. G. Butts; $25,000. Alta Land & Water Co., Grand Junction, Colo.; $100,000. Palouse Irrigating Ditch Co., Tacoma, Wash. trustees, E. C. Smith, C. H. Beers and others; $500,000.

SEWERS.

BUXTON, ME.—The citizens of the village are anxious for a sewerage system, and it is reported that steps will be taken to construct one.

BROCKTON, MASS.—The Sewerage Commissioners have been voted $15,000 for securing surveys and plans. The system to be introduced is that of broad irrigation and downward filtration. The sewage fields will be wholly within the city limits.

QUINCY, MASS.—The Mayor has written a letter to the Council recommending that public hearings be held to discuss the question of sewers.

WALTHAM, MASS.—Additional sewer bonds for $25,000 have been voted.

CENTRAL FALLS, R. I.—Bids for building about 815 ft. of 18-in., 455 ft. of 15-in., 1,250 ft. of 12-in., and 340 ft. of 8-in. pipe sewer and the necessary manholes and catch-basins, will be received until July 6. E. S. Dame, Secy. Sewer Comrs., Town of Lincoln, R. I.

BROOKLYN, N. Y.—The average depth of cut of the sewer in Ward 26, the contract prices of which were published last week, is as follows: Sec. No. 1, 8 ft.; No. 2, 11 ft.; No. 3, 11 ft.; No. 5, 10.03 ft.; No. 6, 12.18 ft.

WILLIMANTIC, CONN.—Sewer extensions will be made in three streets.

ILION, N. Y.—The Stanwix Engineering Co., Rome, is preparing surveys and preliminary work for a proposed sewerage system.

ROCHESTER, N. Y.—The East Side Trunk Sewer Commission will receive bids until July 6 for section 3 of the trunk sewer.

SIDNEY, N. Y.—A committee has been appointed to secure a sewerage system for the town.

TROY, N. Y.—The Board of Contract will receive bids until July 8 for a tile sewer in North Fourth St.

WATERLOO, N. Y.—The Village Trustees will appoint a committee to secure plans and estimates for a sewerage system.

RUTHERFORD, N. J.—Wise & Watson, Engrs., Passaic, have been employed as engineers of the proposed sewers and other improvements, for which the citizens have voted to issue bonds.

ARDMORE, PA.—A perfect drainage system is to be established between this place and Paoli.

READING, PA.—The contract for a sewer in Walnut St. has been awarded to A. H. Tyson at $12,536. The bid was published last week.

RICHLANDTOWN, PA.—The Borough Council has ordered the construction of a drainage system, which will require the laying of about 5,000 ft. of pipe.

ROANOKE, VA.—We are informed that contracts have been awarded to W. F. Patterson, Pittsburg, Pa., for 3 to 11-ft. brick drains in three streets and 2,900 ft. of 24-in. pipe sewer; J. G. Lee & Co., Chattanooga, Tenn., widening and deepening Lick Run; J. A. Gillespie, Chattanoga, Tenn., paving several streets with brick.

DURHAM, N. C.—We are informed by Geo. W. Woodward that a Committee on Sewerage has been appointed, of which A. D. Markham is Chairman. It is proposed to construct a sewer at once, but the town is not yet prepared for an extended system.

CLEVELAND, O.—Bids are asked until July 20 for sewers in two streets. R. R. Herrick, Dir. Pub. Wks.

COLUMBUS, O.—The contract for the sewer in Moler St. has been awarded to J. W. Blackman, at $21,438.

INDIANAPOLIS, IND.—The Board of Public Works has approved plans for a sewer in Washington St., to be 1½ miles long and cost $70,000. Rudolph Hering, New York, has completed his report on a sewerage and drainage system for the city, together with plans for the proposed work.

CHICAGO, ILL.—The City Council has voted in favor of six sewers and several paving improvements in the former town of Lake. Bids are asked until July 6 for the construction of sewers, "7th letting." J. Frank Aldrich, Comr. Pub. Wks.

EAU CLAIRE, WIS.—Bids are asked until July 6 for about one-half mile of sewers, ten manholes, ten catch basins, etc. C. A. Alderman, Cy. Engr.

BOONE, IA.—Plans for a system of sewers are being prepared by M. R. Laird, Engr., Des Moines, who writes us that a part of the work will be advertised in a few days.

CEDAR RAPIDS, IA.—Bids will be received until July 14 for building about 750 ft. of 6 or 6½ ft. two-ring brick sewer, with a bulkhead at outlet. J. D. Wardle, Cy. Engr.

DAVENPORT, IA.—The City Council will award contracts July 6 for 1,870 ft. of brick, and about 20,000 ft. of 15 to 24-in. pipe sewers.

DES MOINES, IA.—The city will construct 10 miles of sewers and 8½ miles of paving this season, at a cost of about $500,000.

IOWA CITY, IA.—About 8,000 ft. of 6 to 12-in. pipe sewer has been ordered laid. A. J. Cox, Cy. Engr.

SPENCER, IA.—Plans for a system are being prepared by M. R. Laird, Engr., Des Moines.

MINNEAPOLIS, MINN.—The City Clerk has been authorized to ask for bids for 2,000,000 sewer brick.

GREAT FALLS.—Bids will be received until July 18 for construction of 48-in. circular brick sewer in Sixth St. J. B. Leslie, Cy. Clk.

OMAHA, NEB.—Bids will be received until July 8 for the construction of a sewer in district 159. P. W. Birkhauser, Chn. Bd. Pub. Wks.

KANSAS CITY, MO.—Bids are asked until July 6 for sewers in district No. 136. J. Donnelly, Cy. Engr.

OGDEN, UTAH.—The lowest bid for the sewers in District No. 6 was that of Hobsen & Wilkenson, $12,828.

SALT LAKE CITY, UTAH.—The City Engineer has prepared plans for 10,956 ft. of sewers, estimated to cost $33,528, and the Council has voted in favor of the construction.

MONTREAL, QUE.—Bids are asked until July 6 for sewers in six streets. P. St. George, Cy. Surv.

HALIFAX, N. S.—Sewer bonds for $21,000 have been sold.

STREETS.

BRIGHTON, MASS.—An appropriation of $10,000 has been made for the completion of Beacon St., at Englewood.

NEW YORK, N. Y.—Three contracts for paving with granite blocks have been awarded to Matthew Baird, aggregating $137,851.

ENGLEWOOD, N. J.—Bids will be received until July 5, by Wm. Cass, Engr., for grading, constructing and macadamizing 4,630 lin. ft of Cedar Lane, from Hackensack River to West Shore R. R. Thos. O'Brien, Town Clk.

RUTHERFORD, N. J.—Bids are asked until July 5 for paving about ten miles with Telford and macadam. Wise & Watson, Engrs., Passaic. See advertisement.

BARNESVILLE, O.—Bids are asked until July 11 for paving Main St. with brick.

CINCINNATI, O.—The Board of Administration will receive bids until July 9 for paving one street with brick and one with macadam.

CLEVELAND, O.—The Board of Control will receive bids until July 13 for Medina sandstone paving, and until July 20 for stone flagging.

MADISONVILLE, O.—The Trustees of Columbia Township will receive bids until July 2 for 3,500 lin. ft. of cement, and 2,000 lin. ft. of plank sidewalk.

MARTIN'S FERRY, O.—Bids are asked until July 11 for 15,000 sq. yds. of brick paving and 1,900 ft. of pipe sewer. R. F. Allender.

SPRINGFIELD, O.—The City Clerk will receive bids until July 9 for $4,900 of 6% sewer bonds, and until July 19 for $20,000 of 6% and $25,000 of 5% paving bonds.

YOUNGSTOWN, O.—The Council has voted to pave Elm St. at a cost of $14,000.

CLINTON, IA.—The City Auditor will receive bids until July 12 for brick paving.

DUBUQUE, IA.—The contract for the improvement of Windsor Ave. has been awarded to C. Ryan at $13,784.

IOWA CITY, IA.—Bids are asked until July 7 for macadamizing and guttering 4,740 ft., 40 ft. wide. Engineer's estimate $2.50 per ft. An open bid looked upon with some favor by the Council is crushing, 50 cts. per yd., and rolling $30 per block of 320 ft. Specifications are on file with and bids will be received by Wm. J. Hots, City Clerk. A. J. Cox, Cy. Engr.

FORT WAYNE, IND.—Bids are asked until July 12 for grading and brick paving. F. M. Randall, Cy. Engr.

TERRE HAUTE, IND.—The City Clerk will receive bids until July 19 for grading, brick and cement sidewalks, and a 12-in. pipe sewer.

PEORIA, ILL.—Bids are asked until July 5 for 27,000 sq. yds. brick paving and 12,000 lin. ft. curbing in Averyville. J. A. Harmann, Engr.

BETHANY, MO.—The town has voted $20,000 for macadamizing the streets.

OMAHA, NEB.—The Board of Public Works will receive bids until July 5 for paving with sheet asphaltum, granite Colorado sandstone, vitrified brick, etc., in 40 streets and alleys; and until July 8 for grading, curbing and paving.

KANSAS CITY, MO.—The City Engineer will receive bids until July 6 for paving and macadamizing.

ELECTRICAL.

PAWTUCKET, R. I.—The Pawtucket Electric Light Co. will soon extend its system of electric lights to the villages of Ashton and Berkley.

ROCHESTER, N. Y.—The city has awarded contracts for five years at 25 cts. per night for arc lights.

WESTFIELD, N. Y.—Bids will be received until July 5 for an arc and incandescent light plant. J. G. Finlay, Village Clk.

LEBANON, PA.—The Committee on Lights report that a plant can be constructed for $20,000.

ELKTON, MD.—The Elkton Electric Light Co. has been awarded a franchise and will at once construct a plant.

JAMESTOWN, MD.—Bids will be received until July 7 for establishing and operating an electric light plant. Alfred Steep.

MONTGOMERY, ALA.—Bids are asked until August 1 for lighting the streets by electricity. J. W. Bullock, Chn., Com. on Lights.

CANTON, O.—It is reported that bids are about to be asked for street lighting.

MATTOON, ILL.—A committee has been appointed by the Council to investigate the best system of electric lighting.

BOONE, IA.—The plant of the Boone Electric Co. has been purchased by Wm. A. Hunter and H. M. Vaughan. A $25,000 plant will be erected.

ASPEN, COLO.—The Consumers' Electric Light Co. is reported about to erect a plant.

LONDON, ONT.—Alderman Parnell and Mr. Graydon have been appointed to procure information in regard to the advisability of establishing an electric plant at Spring Bank, to be owned and controlled by the city, and report to the city in November.

NEW COMPANIES.—Marietta Electric Light, Heat & Power Co., Marietta, Pa.; $1,000; Treas., H. S. Rich. Bath Electric Light Co., Bath, N. Y.; $25,000; Jas. Murphy, H. A. Conway. Ashland Street Railway & Lighting Co., Ashland, Wis.; $75,000; S. S. Fifield, Geo. Harper.

CONTRACT PRICES.

STREET WORK.—Sunbury, Pa.—The contract for paving Market St. has been awarded to J. B. Reed, at $2.08 per sq. yd., for the John A. Porter square brick, 17 cts per cu. yd. for excavating, and 75 cts per lin. ft. for curbing.

Kansas City, Mo.—Contracts for paving with vitrified brick on concrete have been awarded as follows: F. P. McCormick, 2,391 sq. yds., $1.74 per sq. yd.; 5,420 at $1.64; 2,677 at $1.60; C. L. Powell, 1,753 sq. yds., $1,679. The Barber Asphalt Co. was awarded a contract for paving 527 sq. yds. with asphalt, at $2.65 per sq. yd.

Burlington, Ia.—We are informed by Wm. Steyh, Cy. Engr., that proposals were received June 20 for paving eight streets with brick. The bids were as follows: Fred Hoffman, one street, curbing, 50 cts. per lin. ft. and paving $1.67 per sq. yd.; N. Z. Young, grading, 22 to 40 cts. per cu. yd.; curbing, 58 and 60 cts; paving, $1.56 to $1.68; Arthur Starker & Co., grading, 30 to 75 cts.; curbing, 58 and 60 cts.; paving, $1.60 to $1.90; Kropp & Hemphill, grading, 25 and 40 cts.; curbing, 53 and 54 cts.; paving, $1.60 to $1.65.

NOTICE TO CONTRACTORS.

Tenders will be received by registered post addressed to the City Engineer, Toronto, up to 11 o'clock a. m. of July 12, 1892, for the construction of the following works, viz.:

ASPHALT PAVEMENTS.

Yonge Street from King Street to Hayter Street.
Yonge Street from Grenville Street to Bloor Street.
King Street from Sherborne Street to Simcoe Street.
Rose Avenue from Winchester Street to Howard Street.
St. James Avenue from Ontario Street to Parliament Street.
Parliament Street from Carlton Street to Winchester Street.
Devonshire Place from Hoskin Avenue to Bloor Street.

Specifications and forms of the tender may be obtained on and after July 5, 1892, at the office of the City Engineer.

A deposit in the form of a marked cheque payable to the order of the City Treasurer, for the sum of 5% on the value of the work tendered for under $1,000, and 2½% for the value of the work tendered for over that amount, must accompany each and every tender, otherwise it will not be entertained.

All tenders must bear the bona fide signatures of the contractor and his sureties (see specifications), or they will be ruled out as informal.

The committee do not bind themselves to accept the lowest or any tender.

JOHN SHAW,
Chairman of Committee on Works,
Committee Room, Toronto, June 28, 1892.
27-1t.

TREASURY DEPARTMENT, OFFICE of the Supervising Architect, Washington, D. C., June 20th, 1892. Sealed proposals will be received at this office until 2 o'clock p. m., on the 27th day of July, 1892, and opened immediately thereafter, for all the labor and materials required for the erection and completion (except plumbing and heating apparatus) of the United States Post Office building at Ashland, Wisconsin, in strict accordance with drawings and specification, copies of which may be had on application at this office or the office of the Superintendent at Ashland, Wis. Each proposal must be accompanied by a certified check for a sum not less than 2% of the amount of the proposal. The right is reserved to reject any and all bids and to waive any defect or informality in any bid, if it be deemed in the interest of the Government to do so. All bids received after the time stated will be returned to the bidders. Proposals must be inclosed in envelopes, sealed and marked, "Proposals for the Erection and Completion (Except Plumbing and Heating Apparatus) of the U. S. Post Office Building at Ashland, Wisconsin," and addressed to W. J. Edbrooke, Supervising Architect. 27-2t

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ANDERSON WATER-WORKS—NOTICE TO CONTRACTORS.

Sealed proposals will be received by the Trustees of Water-Works of the City of Anderson, Indiana, at their office in said city, until 12 o'clock noon, of Thursday, July 14th, 1892, as follows:

For furnishing materials and constructing one building, to be subdivided into an engine room, approximately 40×60 ft., and a boiler room 40×45 ft. in plan.

Also for two pumping engines (including foundations and fixtures), each with capacity to pump three million (3,000,000) U. S. gallons of water per twenty-four hours, under a pressure for domestic and current service of 65 lbs., with steam pressure at 75 lbs., and with strength of working parts sufficient to safely carry with additional steam pressure a water pressure of 150 lbs. per square inch, during fire service.

Also for two return tubular boilers (including foundations, settings and fixtures), approximately five feet diameter and sixteen feet long; or the equivalent in effective horse power, should any other type of boiler be adopted.

Also for furnishing approximately 1,550 lin. ft., 219 5-10 tons, of 20-in.; 2,400 ft., 167 3-10 tons, of 16-in.; 1,000 ft., 90 6-10 tons, of 14-in.; 7,470 ft., 331 4-10 tons, of 12-in.; 4,550 ft., 153 5-10 tons, of 10-in., and 4,300 lin. ft., 102 2-10 tons, of 8-in. cast iron pipe; total, 1,064 5-10 tons of pipe. Also, approximately, 20 tons of special castings. Also for laying said pipe.

Also for 14 fire hydrants. Also for one 20-in. valve, one 16-in., one 14-in., four 12-in., four 10-in., three 8-in., and three 6-in. stop valves.

The necessary general and detail drawings will be ready for the examination of bidders from and after July 8th, from and after which date also specifications, forms of contract and forms of proposal will be furnished.

The Trustees reserve the right to make such modifications in above quantities as they may elect, either before or after receiving bids for same.

The right to reject any or all bids is also hereby reserved.

LAFE J. BURR, President;
H. CANADAY,
T. M. NORTON,
Trustees.

Attest,
BYRON McMAHAN, Secretary,
J. D. COOK, Toledo, O., Con. Engr.
Anderson, Indiana, June 23, 1892. 27-2t

NOTICE TO SEWER CONTRACTORS.

Sealed proposals indorsed "Proposals for Building Section 6 of the Newton Sewer System" will be received at the office of the City Engineer, City Hall, West Newton, Mass., until Tuesday, July 12, 1892, at 12 o'clock m.; the award of the contract, if awarded, will be made by the Joint Standing Committee on Sewers as soon thereafter as practicable. All proposals must be on the blank furnished by the said Committee, and must be accompanied by a certified check upon a national bank of the cities of Newton or Boston, drawn and made payable to the order of the Treasurer of the City of Newton for $500.

Some of the approximate quantities for the Section are as follows: 16,000 ft. of pipe sewer from 6 in. to 15 in.; 210 cu. yds. brick masonry; 19,000 cu. yds. of material to be excavated at various depths.

Plans can be seen and specifications and forms of contract can be obtained at the office of the City Engineer.

Each bidder is required to make a statement indicating what sewer work he has done, and to give references that will enable the Committee to judge of his business standing, and no bid will be received in case the bidder has not looked the work over on the ground.

The Committee reserve the right to reject any and all bids if they shall deem it for the interests of the City of Newton so to do.

William F. Harbach, Chairman; Edward B. Wilson, Erastus Moulton, George S. Downs, Charles W. Knapp, Joint Standing Committee on Sewers.

City Hall, West Newton, Mass., June 29, 1892.

ALBERT F. NOYES,
City Engineer.
27-1t

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SUMMER COURSES OF INSTRUCTION.

During the summer of 1892 it is expected that courses of instruction will be given as follows:

Chemistry, four courses, viz.: Fundamental Principles of Chemistry; Qualitative Analysis; Quantitative Analysis; Organic Chemistry. Botany, two courses, viz.: Vegetable Morphology and Physiology and Microscopical Anatomy of Phanerogams; Cryptogamic Botany. Physics, two courses. Geology, three courses. Engineering, three courses, viz.: Topographical Surveying; Railway Surveying; Electrical Engineering. Mechanical Drawing; Physical Culture, two courses; Physiology and Hygiene; American History; Socialism and Social Problems; Trigonometry; Horticulture; English; German, two courses; French, two courses; History and Art of Teaching; Elocution; Courses at the Medical School.

Circulars descriptive of these courses and other information may be obtained on application to the Secretary of Harvard University, Cambridge, Mass. In addition to the above mentioned courses, certain lectures on methods of instruction will be given by teachers in the several departments represented by the schools. These lectures will be open, without charge, to the persons who are enrolled as members of any of the summer schools in the University. In general these courses are adapted to the needs of those who intend to be teachers in the several subjects. Several of the more elementary, however, are intended to meet the needs of beginners, and may be taken by students in lieu of the corresponding courses in the College and the Lawrence Scientific School, and may be counted towards a degree. During the session of the schools the College Library will be open from 9 A. M. till 5 P. M. The Museum of Comparative Zoology, the Peabody Museum, and the Mineralogical Collection in Boylston Hall are also accessible to students during the summer vacation. In general the fees for the above mentioned courses, except those in Chemistry, Engineering and Physical Training and Elocution, are $20 for each course.

Board and lodging may be obtained in Cambridge during the summer vacation at a cost of from $5 to $10 per week.

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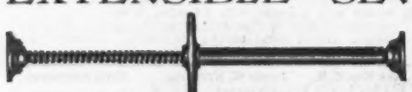

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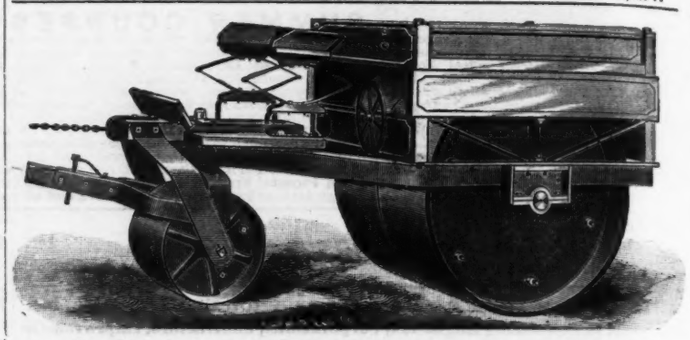

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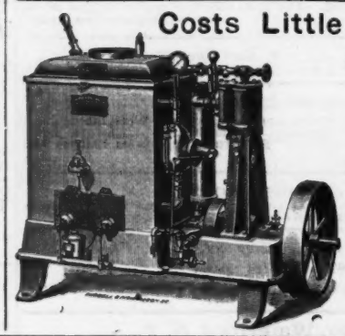

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Groton Bridge & Mfg. Co.	27
Guillaume, Alfred	1
Gurley, W. & L. E.	16
Hall Signal Co	1
Harlow & Co., Jas. H.	30
Harrisburg Fdry. Machine Wks.	16
Hastings Pavement Co.	17
Hazen, Allen	2
Heer & Selig	16
Heller & Brightly	16
Hersey Mfg. Co.	14
Hering, Rudolph	2
Hildreth, R. W., & Co.	2
Hill, John W.	2, 12
Hinson Car Coupler Co.	7
Hodge & Co.	30
Holmes, A. L.	12
Holly Manufacturing Co.	30
Holyoke Hydrant & Iron Wks.	13
Howard Harrison Iron Co.	19
Howell, D. J.	2
Hughes Steam Pump Co.	31
Hunt & Co., Robt. W	2
Hunt & Clapp	2
Hutton, Wm. R.	2
Industrial Works	25
Ingersoll-Sergeant Rock Drill Co.	8
Iredell, F. W.	20
Jackson & Woodin Mfg. Co.	34
Jackson, D. C.	2
Janney-Hein Company	7
Johnson Railroad Signal Co.	
Johnson & Wilson	36
Johnson & Flad	2
Joseph Dixon Crucible Co.	18
Kalamazoo R.R. Vel. & Car Co.	11
Kelly, O. S., Co.	6
Ketcham & Co. Chas. F.	8
Keuffel & Esser Co.	16
Keystone Bridge Co.	27
King Bridge Co.	27
Kirk & Son, Arthur	19
Knowles Steam Pump Works	33
Lafayette College	3
Laidlaw & Dunn Co.	35
Lake Shore Foundry	33
Landreth, Olin H.	2
Lawrence Cement Co.	36
Lawrence Scientific School	3
Lehigh Valley Creosoting Wks	29
Lehmann, Karl L.	2
Leonard, H. Ward & Co.	1
Leslie & Trinkle	17, 36
Lewis, Harry J.	2
Lidgerwood Mfg. Co.	25
Link Belt Machinery Co.	13
Livengood, W. C.	8
Locke, A. W. & F. B.	2
Long & Co., Dennis	38
Lookout Sewer Pipe Co.	18
Loweth, Chas. F.	2
Ludlow Valve Mfg. Co.	13
Lucius, Albert	2
Lundie, John	2
Maslin & Son	33
Mason, W. P.	2
McAuley & Peters' Tent and Awning Co.	4
McCain, F. J. & Bro.	29
McConway & Torley Co.	7
McGrew, Abram	3
McLeod, John	2
McMath & Sons, R. E.	3
McNeal Pipe & Fdry. Co.	35
Marion Steam Shovel Co	25
Massillon Bridge Co.	28
Meacham & Wright	17
Meier & Foster	2
Mellert F'dy & Machine Co.	35
Merrill-Stevens Mfg. Co.	11
Metcalf, Paul & Co.	6
Michigan Brass & Iron Works	13
Michigan Pipe Co.	35
Middleton, W. S.	12
Millar & Sons, Chas.	19
Missouri Valley Bridge & Iron Works	26
Moffet, Hodgkins & Clarke	3
Montague & Co.	19
Morse & Son, A. J.	32
Mosby, S. B. & Co.	2
Mt. Vernon Bridge Co.	29
Mueller, H., Mfg. Co	14
Mundy, J. S.	29
Murray, Alfred J.	29
Nat'l F'dry & Pipe Wks.	33
National Meter Co.	15
National Paint Works	30
National Surface Guard Co.	9
National Tube Works	32
National Water Purifying Co.	36
Neuchatel Asphalt Co., Ltd.	17
N. Y. & Bermudez Co.	17
N. Y. & Rosendale Cement Co.	36
N. Y. Car Wheel Works & Co.	36
Norton, F. O.	36
Norwalk Iron Works Co.	5
Oastler, W. C.	6
O'Flaherty & Son, Daniel	3
Ohio Pipe Co	35
Ohio Valley Fire Clay Co.	31
Oil Well Supply Co.	14
Old Dominion Creosoting Wks.	31
Osborne & Son, R. B.	36
Osgood Dredge Co.	27
Otis & Chapman	27
Ottewell, A. D.	3
Otto Gas Engine Works	5
Pancoast & Rogers	35
Paret, M. P.	3
Park Fire Clay Co.	1
Parker, M. S.	3
Parker, Field & Mitchell	31
Parsons, Wm. Barclay	3
Passaic Rolling Mill Co.	30
Pelton Water Wheel Co.	12, 25
Pencoyd Bridge & Constr. Co.	29
Pencoyd Iron Wks.	27
Pennsylvania Steel Co., 1, 9, 27,	30
Penney Surveying Co., W. W.	3
Peet Valve Co.	13
Pfister, Herm.	16
Phillips, Hiram	3
Phœnix Bridge Co.	26
Phosphor-Bronze Smelting Co.	14
Pittsburg Bridge Co.	28
Pittsburg Locomotive & Car Works	6
Pittsburg Reduction Co.	20
Poole, Robt. & Son Co.	32
Porter Boiler Mfg. Co.	30
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Porter Mfg. Co.	34
Pottsville Iron & Steel Co.	28
Prince, L. M.	16
Prosser & Son, Thomas	6
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Q and C Company	18
Queen & Co.	16
Radford Pipe & Foundry Co.	34
Ramapo Iron Works	8
Rand Drill Co.	4
Randolph, T. F.	16
Raymond & Bay	3
Remington & Co.	4
Rendrock Powder Co.	5
Rensselaer Mfg. Co.	12
Rensselaer Polytechnic Institute	3
Ricker, Lee & Co.	6
Ricker & Wing	3
Ricketts, Palmer C.	3
Riehle Bros.' Testing Machine Co.	9
Riney & Co., M.	29
Ripley, H. C	3
Riter & Conley	30
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Roberts, A. & P. & Co.	27
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Ross Valve Co	13
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Schrader & Son	12
Schoen Mfg. Co.	8
Shaffer & Schniglau	28
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Shaw, Edw. S.	3
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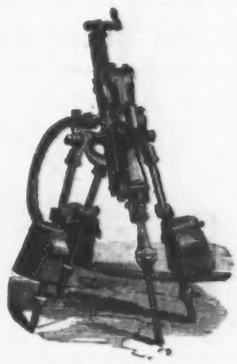

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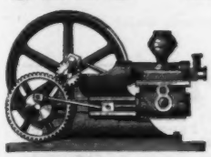

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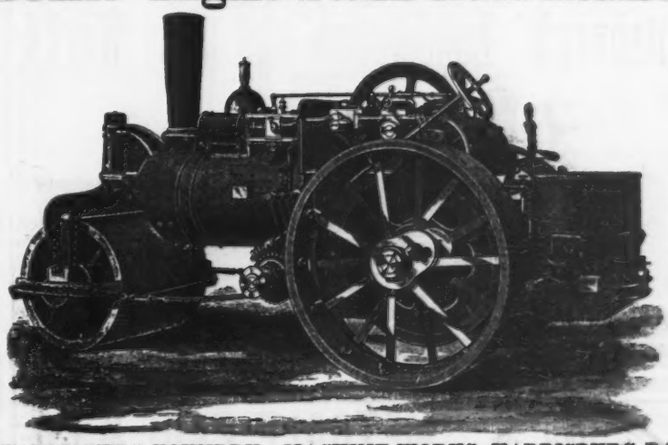

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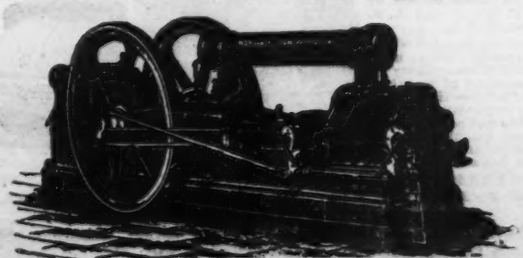

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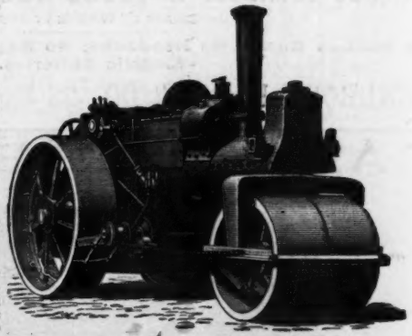

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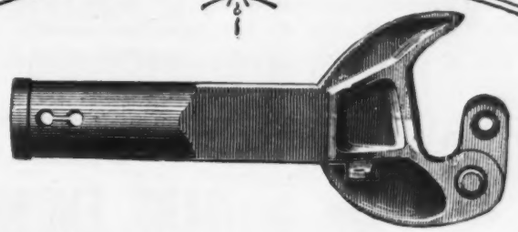

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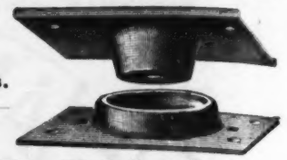

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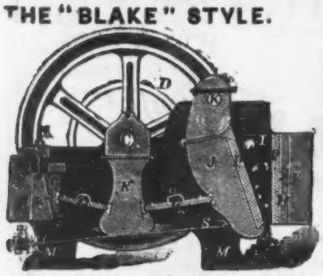

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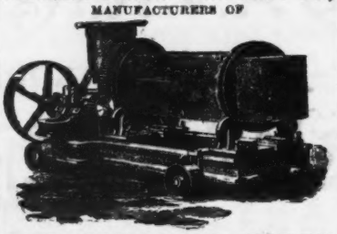

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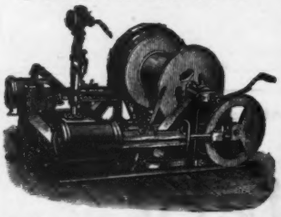

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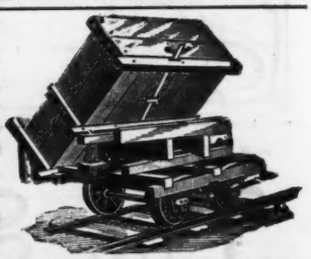

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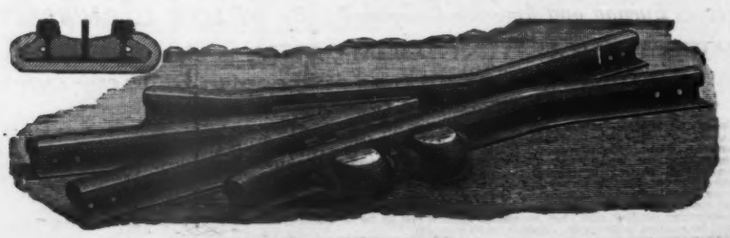

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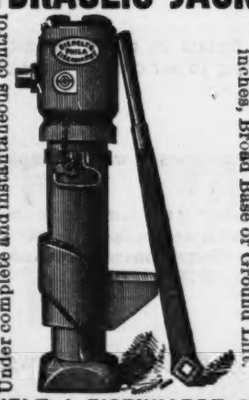

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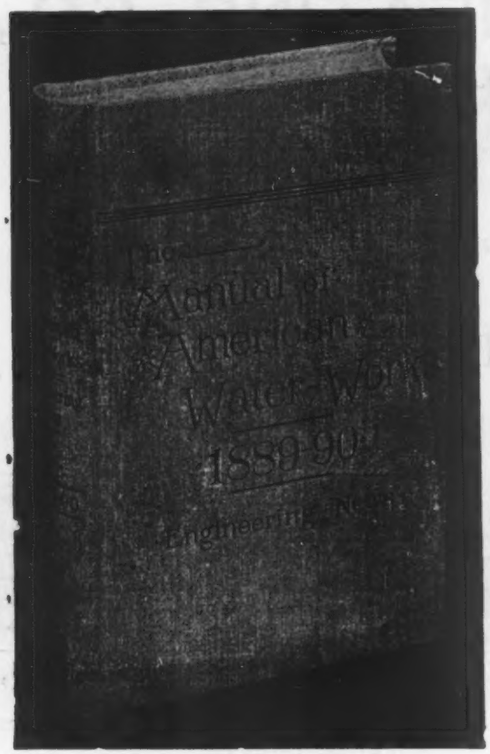

THE

Manual of American Water-Works

FOR 1891

This Issue of the Manual brings down by two years the information contained in the 1889–90 volume, a cut of which is shown at the left. It is prepared on the same general lines as previous issues, with exceptions and improvements noted below.

Over 2,800 Cities, Towns and Villages Included.

This Issue of the Manual describes water-works, mentions outside towns supplied, or towns having fire protection systems only, describes water supply systems (*i. e.*, those furnishing water for domestic use but not for fire protection), and describes projects of promise to the grand total of 2,850, as follows:

Water-works plants	2,132
Outside towns supplied	179
Water supply systems	131
Fire protection systems, about	50
Works projected, with fair prospects of construction	348
	2,840
Deduct duplicate works	29
Total cities, towns and villages included	2,811

This Issue of the Manual gives for many works statistics for several years, showing the miles of mains, number of taps, meters and hydrants, average daily consumption, cost, debt, expenses and revenue for each year.

This Issue of the Manual includes both the 1880 and 1890 census populations of the several towns.

This Issue of the Manual contains a list of all towns having works, arranged in order of population, in accordance with the 1890 census, with ownership, whether public or company, designated for each town. This list alone is worth double the price of the book to the man who is studying the problem of providing an adequate supply to a given town, or endeavoring to settle the vexed question of hydrant rental or water rates; for by turning to the above named list he can select as many towns as he wishes (if he doesn't wish more than there are) of about the same size as the town in question, and compare their works with his. If desirable he can separate these into public and private plants.

This Issue of the Manual, like all preceding ones, has an Introduction in which the contents of the body of the book are summarized and analyzed. The present Introduction treats of the following subjects:

Present Status—Showing for each state the number and cost of works, miles of mains, number of taps, meters and hydrants.

Growth in Numbers and Population Supplied—Showing number of works in each group of states at the end of each decade from 1801 to 1870, and at the end of each year from 1870 to 1890; also growth of populations supplied from 1880 to 1890.

Size of Towns Supplied and Projected Works—Showing by groups of states the size of the towns supplied in 1880 and 1890, and by states the number of projected works.

Management of Public Water-Works—Showing, in general, to what bodies public works are intrusted, how these bodies are raised to office and how long they hold office.

Consumption of Water and Use of Meters—Showing in detail consumption of water and use of meters in the 50 largest cities of the United States and how meters reduce consumption; also showing the same facts regarding all cities having 50 per cent. or more of taps metered. This is a question of great importance to every water-works man.

Ownership—Showing the relative growth of public and private water-works since 1800.

Franchises—Showing how cities and towns have protected or failed to protect their interests in granting franchises to water companies—provisions as to regulation of rates and purchase of works by the city, and length of franchises.

While a general description of each water-works is given in the 1891 Manual, much of the detailed descriptive matter in the last issue is omitted. *All new works, all changes and improvements since the last issue, and the latest obtainable statistics for both new and existing works are included in the volume advertised herewith.* ☞ But those wishing the exhaustive descriptions of many works given in the 1889-90 Manual, the illustrations of dams and reservoirs, the water rates of about 750 cities and the list of officials, engineers and contractors are referred to the 1889-90 issue.

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Letter published in Engineering News of Oct. 24, 1891, recently circulated extensively by circular.

INDIANAPOLIS, IND., Oct. 13, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: There was a test of railway cattle guards here this afternoon under the charge of the road department of the "Big Four" system. There were five guards shown of the so-called surface guards and one of the old style pit guard.

The National Cattle Guard Co., of Chicago, had two guards; the Kalamazoo Velocipede & Car Co., one; the Shorthill patent sewer pipe guard, of Marshalltown, Ia., one, and the Bush Cattle Guard Co., of Kalamazoo, one.

The guards were put in side by side and then a drove of 16 cattle were turned into a small pen on one side so that to go out they would be obliged to cross one or the other of the guards. The result was that one of the National Co.'s guards was crossed first, then the Shorthill sewer pipe guard was crossed by three head of cattle at once. The third guard attempted was that of the Kalamazoo Velocipede & Car Co. The cattle crossed and returned back over it again with perfect ease. After that the guards were all closed up, except one of the National guards and the Bush surface guard, of Kalamazoo.

In a very few minutes three head of cattle had crossed the National and two head had crossed the Bush, leaving only the pit guard that had not been crossed by one or more head of cattle.

All of the surface guards were then closed, and in a few minutes two head of cattle had crossed the pit. Consequently the railway companies can choose from six different guards that allowed stock to cross with ease.

The guards were all fairly placed and the trial fair, except the cattle were of that class that are used to feeding in the outskirts of a city and are great hustlers after feed.

I will not attempt to draw any conclusions, but will leave it for you or your readers to do so if you care to attempt it. A CIVIL ENGINEER.

Editorial in Engineering News of June 16, 1892, referring to letter opposite.

The continued silence of the writer of the communication signed "Civil Engineer," and published in our issue of Oct. 24, 1891, in spite of our repeated requests that he will either support his statements or withdraw them, warrants us in concluding that that letter was an imposition on the confidence of this journal in the writer's apparent good faith. As we have stated, the letter must have been duly signed with some name or accompanied by an inclosed card, or it would never have been published at all, but it is impossible for us to remember at this distance of time what name was signed to it. The letter purported to describe the Indianapolis cattle guard tests, as stated in our issue of May 26. It gave an entirely different account of them from what we subsequently obtained from official sources, and we learn with deep regret that it is being circulated in aid of trade rivalries, reprinted as from this journal in order to establish its genuineness. We are now thoroughly convinced that the letter was not sent us in good faith, and under the circumstances we deem it our duty to warn all our readers that no attention and no weight should be given to it in whatever form presented.

THE OFFICIAL REPORT STATES: The cattle crossed the Seymour Guard in 5 minutes, the Bush in 8 minutes, the Kalamazoo in 12 minutes, the Shorthill in 20 minutes, and over these guards the cattle crossed repeatedly, and with little hesitation. The pit was the next guard crossed and **THE NATIONAL THE LAST** to succumb to this exhaustive test. The National and pit guards were crossed by two head of cattle only. Time of test 2 hours and 40 minutes.

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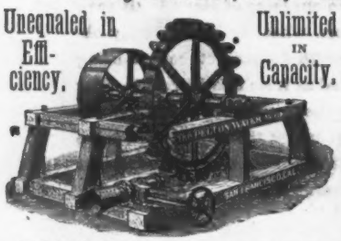

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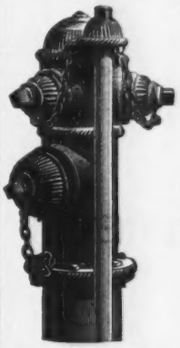

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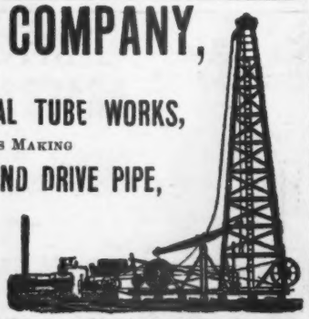

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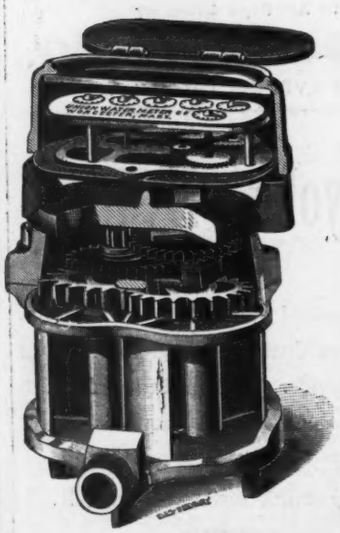

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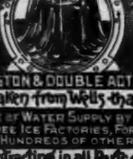

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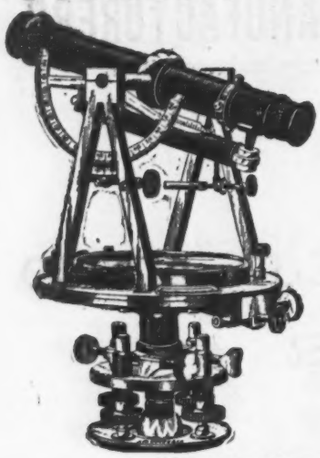

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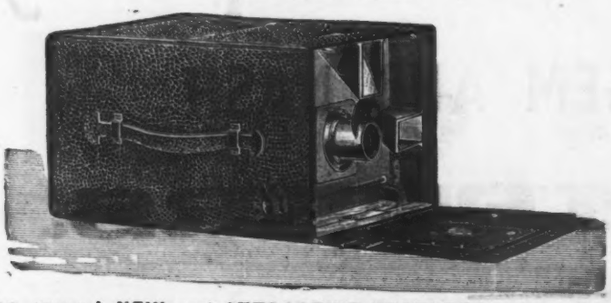

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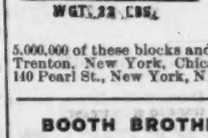

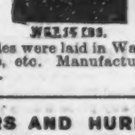

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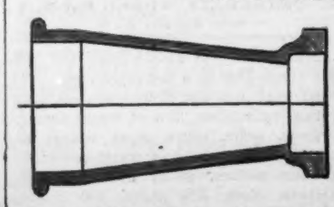

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Dated, June 9, 1892. 25-4t

NOTICE TO SEWER CONTRACTORS.

SEALED PROPOSALS will be received at the office of the Board of Public Works, in the city of Knoxville, Tenn., at 2 o'clock p. m., on the 7th day of July, 1892, for constructing a system of sewers divided into two sections composed of 2 miles of brick sewer from 24 x 36 to 38 x 57 inches, and 47 miles of pipe sewer, from 8 to 24 inches; 683 manholes, 336 flush tanks.

Form of proposal, copies of specifications and instruction to contractors may be obtained at the office of the City Engineer, and the plans and profiles may be seen at his office on and after June 22, 1892. Bids will be received on each section separately. Each bid must be accompanied by a certified check for $5,000, payable to Jno. Gleason, Chairman Board of Public Works, as a guarantee of the good faith of the bidder.

The Board reserves the right to reject any or all bids.

By order of the Board of Public Works.
JOHN GLEASON,
Chairman.

M. NICHOLSON,
City Engineer. 26-3t

NOTICE TO CONTRACTORS.

Office of the City Clerk.
Portsmouth, O., May 28, 1892.

Sealed proposals will be received by the undersigned at his office until noon, Wednesday, July 6th, 1892, for the privilege to construct and operate a street railroad in the said city by electricity or any other improved system of motive power that may come into use, for the period of twenty-five (25) years, under the terms and conditions of an ordinance establishing a street railroad route to be known as Route No. 1, and providing the mode and manner of the construction and regulations for the operation of the same, passed by the City Council of said city, January 29th, A. D., 1892, and also an ordinance to amend Sections 2, 5 and 16 of said ordinance passed by the City Council of said city May 18, A. D., 1892.

All proposals shall be accompanied with $25 in cash to defray the costs and expenses of publication, etc., incident to the grant, which money will be returned to any company, corporation or individual failing to obtain the grant of such franchise.

The city reserves the right to reject any and all bids.

Given under my hand the day and year first above written.

S. G. McCOLLOCH, City Clerk. 22-5t

STREET PAVING.

SEALED PROPOSALS.—The Mayor and Council of the borough of Rutherford, N. J., will receive proposals until 7 p. m., July 5, for paving with Telford and Macadam pavements about 10 miles of streets in said borough.

Plans and specifications may be seen at the offices of J. P. Cooper, on Railroad Ave., Rutherford, N. J.; Messrs. Wise & Watson, C. E., Passaic, N. J.; and Jas. Owen, C. E., 800 Broad St., Newark, N. J.

The Mayor and Council reserve the right to reject any or all bids if deemed for the best interests of the borough.

Proposals must be accompanied by a certified check for $1,000, which will be retained till the contract is awarded, and a bond to the amount of $10,000 in two sufficient sureties will have to be executed by the successful contractor.

ALEXIS McNULTY, Borough Clerk.
WISE & WATSON, Engineers,
26-2t in charge of Borough Work.

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A FULL ASSORTMENT OF WATER AND GAS WORKS SUPPLIES.

NOTICE TO CONTRACTORS.

Sealed proposals will be received by the City Clerk of Carbondale, Penn., until 8 p. m., July 2, 1892, for the construction of about 18,000 lineal feet of main and lateral pipe sewers according to plans and specifications on file in the City Engineer's office in the City Hall, where copies of the specifications and the ordinance authorizing the construction of said sewers may be obtained.

Bidders are required to inclose with proposal, cash or certified check for 5% of amount of bid as a guarantee of good faith. Said amount to be forfeited to the City in case the successful bidder fails to execute a contract within 10 days if awarded the same.

Proposals to be in duplicate, to be sealed and indorsed "Proposals for Sewers to Be Constructed in the Second Sewer District," and addressed to the City Clerk.

The City reserves the right to reject any or all bids. R. D. STUART,
WALTER FRICK, City Clerk.
City Engineer. 25-3t

NOTICE TO SEWER CONTRACTORS.

Office of City Clerk,
Great Falls, Mont., June 16, 1892.

Sealed bids will be received by the undersigned at his office in the Dunn Block until 12 m., Monday, July 18, 1892, for the construction of a forty-eight-inch circular brick sewer on Sixth St., north, according to plans and specifications on file in the City Engineer's Office.

The right to reject any and all bids is hereby reserved.

Done by order of the City Council.
J. B. LESLIE,
27-3t City Clerk.

LACON, ILL., WATER-WORKS.—Sealed Proposals will be received by the City Council of the City of Lacon, Marshall County, Ill., at the office of the Mayor until Friday, July 8, 1892, at 1 o'clock p. m., for furnishing the material and the construction of Water-Works.

The works consists in furnishing and erecting a duplex steam pump 800,000 gallons capacity per 24 hours; also furnishing about 90 Tons of Cast Iron Pipe with necessary specials—laying Pipe, furnishing Valves and Hydrants, and furnishing and erecting complete a Steel Tank on a steel tower. Tank to be 20 ft. diameter, 25 ft. deep, with spherical bottom. Tower, 40 ft. high.

Proposals must be made on blanks furnished by the City Clerk and be accompanied by cash or a certified check equal to not less than 5% of the bid, payable to J. S. Thompson, Mayor of Lacon, Ill., as a guarantee for the execution of contract.

Proposals are solicited on all or any part of the work.

Blank proposals and specifications may be obtained and maps and plans will be on exhibition at the Mayor's office, Lacon, Ill., and at the office of the Engineer in Y. M. C. A. Building, Peoria, Ill., on and after June 18, 1892.

The right is reserved to reject any and all proposals and let the work to the most satisfactory bidder.

The successful bidder or bidders will be required to enter into written Articles of Agreement and to give bond in sum of not less than 20% of the total amount of his contract. By order of the City Council.

J. S. THOMPSON, Mayor.
Attest: J. R. CHAPMAN, Clerk.
25-3t JACOB A. HARMAN, Engineer.

NOTICE.—PUMPING ENGINE.

The Martin's Ferry Water-Works desires to purchase a Pumping Engine of 2,000,000 gallons capacity. All complete. For further information address the Martin's Ferry Water-Works, Martin's Ferry, Ohio. By order of the Board.

CHAS. S. MOORE,
Superintendent.
27-4t

TRENCHING AND PIPE-LAYING.

Sealed proposals endorsed "Tenders for Trenching and Pipe-Laying" will be received at the office of the Syracuse Water Board, City Hall, Syracuse, N. Y., until 2 o'clock p. m. of Monday, July 11, 1892, for trenching and laying cast iron water pipe and special castings, setting stop-gates, hydrants and other work connected therewith, in the city of Syracuse, as follows: A 16-in. main in East Water St., from Warren to Montgomery and from Almond to Pine St., 3,750 lin. ft. A 20-in. main in West Genesee St., from West to Geddes St., 3,200 lin. ft. A 12-in. main in Grape St., from East Water to Fayette St., 700 lin. ft.

The work must be commenced in 10 days from the execution of the contract and be fully completed as to East Water St. on or before September 10; Grape St. on or before September 20, and West Genesee St., on or before November 1, all in the year 1892.

The person or persons to whom the work may be awarded will be required to execute the contract with the required surety in the sum of $1,500 within five days after notice of the award.

Blank forms of contract, specifications, bond and proposals, can be obtained at the Engineer's office of the Syracuse Water Board, room 8 Granger Block, in said city, on application.

JAMES B. BROOKS,
Secretary Syr. Water Board.
Syracuse, June 23, 1892. 26-3t

BRICK PAVEMENT.

Sealed bids will be received at the office of Jacob A. Harman, engineer, room 100, Y. M. C. A. Bldg., Peoria, Ill., until 6 o'clock p. m., on the 5th day of July, A. D. 1892, and will be opened at the regular meeting of the Village Board of the village of Averyville, Peoria County, Ill., to be held on the evening of the above named date, for grading, furnishing and setting curb-stone, and paving, with commercial size brick, Galena Road, in said village.

The quantity of paving is approximately 27,000 sq. yds.; length of curbing, approximately, 12,000 ft.

The village reserves the right to reject any and all bids.

JOHN KNOTT, Pres.
Attest, F. N. VAN DEVENTER.
JACOB A. HARMAN, Engineer.
26-1t

PROPOSALS FOR GIRDER SPAN INDIANA STREET BRIDGE.

Office of the Department of Public Works,
Chicago, Ill., June 27, 1892.

Sealed proposals will be received by the city of Chicago until 11 a. m. Friday, July 8, 1892, for the construction and erection of a girder span, between the east river pier and the east abutment of the Indiana St. bridge, according to plans and specifications on file in the office of the Department of Public Works of said city. Proposals must be made out upon blanks furnished at said office, and be addressed to said Department, indorsed "Proposals for Girder Span, Indiana St. Bridge," and be accompanied with $200 in money, or a certified check for the same amount on some responsible bank doing business in the city of Chicago, and made payable to the order of the Comr. of Public Works. The Comr. of Public Works reserves the right to reject any or all bids. Bids will not be received after the hour above named. No bids will be received except those coming from bridge manufacturing companies owning and operating their own plant. No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the Comr. of Public Works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him. Companies or firms bidding will give the individual names, as well as the name of the firm, with their address. J. Frank Aldrich, Comr. of Public Works.

BRIDGE NOTICE.

Proposals will be received by the Board of Chosen Freeholders of Salem County, New Jersey, at their regular meeting on
JULY 13, 1892,
for the construction of an Iron Highway Bridge, with the Superstructure therefor, over Alloway Creek, at Quinton, N. J.

Plans can be seen at office of the undersigned, to whom application can be made for printed specifications.

J. FORMAN SINNICKSON,
Address: Salem, N. J. Clerk.

For other proposals see page xxi.

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WANTED—All consulting engineers, corporations, contractors, etc., to read Paret's advertisement about surveys. See page III.

WANTED—Continuous girders or drawbridges to calculate—either constant or variable moment of inertia. New graphical method. Address, C. H. LINDENBERGER, Wayne Hotel, Detroit, Mich. 1-35t

WANTED.—Bridge engineer, designer and draftsman whose present engagement expires July 1, would like to make an engagement with a railroad or bridge company. Am capable of taking entire charge of work, a graduate civil engineer of first-class experience, and can furnish the best of references, both as to character and ability. J. FRED. TEMPLE, San Francisco Bridge Co., Seattle, Wash. 14-tf

WANTED—Indices to Engineering News for volumes 14, 17, 22, 23, 24, 25. Will pay 10 cts. a copy if in good condition. Address this office.

WANTED—Engineering News for Jan. 3 and Dec. 5, 1891. Will give 10 cents each. Address this office.

WANTED.—Engineering News for Oct. 11, 1884. Will pay 30 cts. Must be in good condition. W. H. L., care Eng. News.

WANTED.—Assoc. Am. Soc. C. E. would like position as bridge draftsman. Experience as computer and author. Address L., care Engineering News. 22-6t

WANTED—Engineering News for 1892. Nos. 2, 3, 4, 6, 7 and 8, for which we will pay 15 cts. per copy, or we will send a copy of Cross' Field Book for any single number. In mailing, please roll long way of the paper and wrap full length; otherwise the leaves will tear, and we have no use for the torn copy. The number of each wanted is limited to 25 copies. Engineering News Pub. Co.

WANTED—"Engineering" (London), for 1890 and 1891, complete, with indexes and title pages. Will pay $5 per yearly volume, unbound. Address, MECHANICAL ENGINEER, care Eng. News. 24-6t

WANTED—Position as chainman, transit or level rodman, by a college student who has had some experience; could run a level; satisfactory references. S. R. Jenkins, Box 221, Grafton, W. Va. 25-3t

WANTED—A bridge engineer, with 15 years' experience in designing and estimating structural iron work, is desirous of making a change. Is competent to take charge of work, and can furnish the best of references. Address "B. W." care Engr. News. 25-3t

WANTED.—Position with Civil Engineer. Several years' experience on sewerage and general engineering work. Address, O. S., 20 46th St., Chicago, Ill. 25-3t

WANTED.—Copy Engineering News for March 12, 1887. Will pay 25 cents. Address "E. M.," care Engineering News. 25-tf

WANTED—One more good bridge draftsman. Apply to THE BERLIN IRON BRIDGE CO., East Berlin, Conn. 26-2t

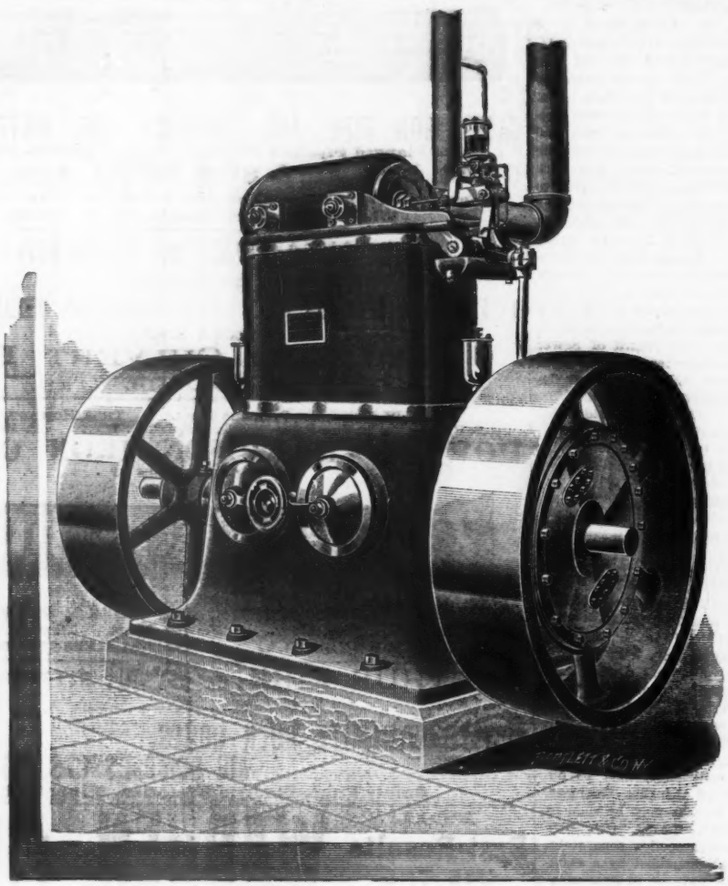
WANTED.—A mechanical expert in fitting and handling Standard R. R. wrecking outfits, by which anything on wheels can be easily and quickly handled, wants a job. Address, EXPERT, Engineering News. 26-3t

WANTED—Two first-class draftsmen, experienced in ornamental map work, lettering and colored topography. Give references. Address JOHN C. WATT, Hammond St., Cambridge, Mass. 26-3t

WANTED.—A Civil Engineer and Architect, who intends to open an office in one of the most prominent Western cities, wants a partner with some experience and capital. Best of references given and required. Answer to "J. E." Engineering News. 26-3t

WANTED.—A young man would like position as level, rod, chain or run transit; Location or Construction work. Address RODMAN, 265 Varick St., Jersey City, N. J. 26-3t

WANTED.—An Engineer of 25 years' experience, 15 years with several important railroads in the United States, 10 years in South America as Chief Engineer and Manager, superintended labor of construction for account of company, purchased materials and operated roads, desires an engagement as Engineer or Superintendent of Construction with a Railroad or Contractor. Recommended by last and former employers. Address ENGI-



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WANTED.—A metallurgical chemist and engineer, having had large experience in the manufacture of rails and structural materials in connection with the largest steel works in the country, desires an engagement with railroad company or engineering firm. Address STEEL EXPERT, care Engineering News. 26-3t

WANTED—A Practical Engineer and bridge builder, with a capital of $7,000 to $10,000, to enter firm well known in Canada. The best of references given. Address, C. W. R., Bridge Builder, Montreal. 26-2t

WANTED.—A first-class bridge draftsman wants position. Address, O. H. L., care Eng. News office. 26-2t

WANTED.—By bridge engineer, experienced in computing, designing, shop and field; work, transit, level, masonry. Has been assistant engineer for the best American Bridge Co., and bridge engineer for prominent railroad; about 30. Has never been out of work. Will send best testi-

WANTED.—Position on railroad work or in bridge company by a '92 graduate of engineering in Yale Scientific School. Address C. W. MERRELS, 24 Pearl St., New Haven, Conn. 26-3t

WANTED—One copy each of the Reports of E. J. DeSmedt, Chemist, to the Commissioners of the District of Columbia, for the years 1885 and 1886, on Cements, Asphalts, Etc. Address Engineering News, stating price and condition of copy. 24-3t eow

WANTED.—D. P. LeFevre, C. E., ex-Cumberland City Engr., a married man and graduate of Lafayette College, desires a position on any kind of engineering work in the state of Colorado. For reference address Mr. J. W. Galbreath, Ch. Engr. of Maintenance of the W. Va. Central R. R., Cumberland, Md. Address D. P. LeFEVRE, C. E., Cumberland, Md. 27-9t

WANTED—Correspondence with a progressive bridge company for the utilization of an important patent concerning skew pin connected joints. CHAS. STEINER, Civil Engineer, 405 Temple Court, Minneapolis, Minn. 27-4t

WANTED—By a recent graduate of the Rens. Poly. Inst., Troy, N. Y., a position in line of mechanical engineering or machine construction. Address C. W., care of Engineering News. 27-3t

WANTED.—A member Am. Soc. C. E. with 14 years' experience is open to engagement to design or superintend waterworks or sewerage construction. Office

WANTED.—An experienced railroad draftsman wants a situation. Very best of references from several roads. Neat, accurate and a hard worker. Address X., 34, care Eng. News. 27-4t

WANTED.—Mechanical engineer, first-class, with best references and 14 years' experience, wants position. Address R. T. S., Eng. News. 27-3t

WANTED.—A young graduate mechanical engineer, having four years' practical experience, is open to engagement. The advertiser is well posted on indicator practice, foundations, and the installation of power plants and machinery; a reliable draftsman, quick at detailing, also conversant with modern methods of duplicating parts economically. Position, rather than salary desired. Excellent references. Address "PROGRESSIVE," care Engineering News. 27-2t

WANTED.—First-class second-hand transit; state make, how old and full information; must have leveling attachment. Address A. F. WALKER, Camden, S. C. 27-2t

WANTED.—Location and Construction Engineer, fine draftsman, 6 years' experience, technical education, would take charge of railroad construction at moderate salary. Experience on masonry and girder work. At references. FULTON, 2101 Third Ave., N. Y. 27-3t

WANTED—Immediately, 3 experienced bridge draftsmen: $100 per month. ENGINEERING EMPLOYMENT BUREAU, Syracuse, N. Y. 27-1t

WANTED—To rent or buy second-hand transit and level. Address, with de-

WANTED—Engineering News for these dates: 1883, May 26 and June 3, 10, 17; 1885, Feb. 28, June 6; 1888, Jan. 7, Apl. 28, May 14; 1889, Apl. 7, May 4, Oct. 12; 1890, Jan. 25, Feb. 15, 22, March 22. Will pay 15 cts. for one copy of each Papers sent not needed returned. Address, F. A. PECKHAM, 1118 Monadnock Bldg., Chicago. 27-3t

WANTED.—A civil engineer of seven years experience in railroad work, North and South, desires position as stenographer where his engineering knowledge will be useful to employer. Is an able stenographer, thorough field and construction man and good draftsman. Has transit and typewriter, and will go anywhere. Good references. Address, B. T. ELMORE, care Engineering News. 27-3t

WANTED.—Young man, good mathematician and experienced in use of instruments, desires position of any kind on engineering corps. Best recommendations from previous employer. Address W. E. SOMERVILLE, Govanstown, Md. 27-3t

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NOTICE TO BIDDERS.

The undersigned begs to inform those having contracts that the same can be furnished with Italian laborers upon special agreement, on favorable conditions; strict and reliable dealings. Address, DONALD CUOZZO, Italian Labor Employment & Supply Agency, 386 Broome St., New York City, N. Y.

N. B.—No orders entertained that require less than 100 men.

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DONATO CUOZZO, See Adv., p. iv.
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FOR SALE—At South Bethlehem, N. Y., a first-class limestone quarry, from which large amounts of construction stone have been taken. Quarry is connected by rail with West Shore R. R.; will be sold cheap. Address FRANK A. JAGGER, Albany, N. Y. 25-5t

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2,500 tons 60-lb. steel T rails lying in Ohio.

10 miles 35-lb. steel lying South.

300 tons 30-lb. iron lying South.

400 tons 35-lb. iron lying South.

450 tons 30-lb. iron lying North.

Also 250 tons 35-lb. tram rails.

Address, J. JEWKES, Railway Equipment, P. O. Box 1306, Pittsburg, Pa.

26-3t

FOR SALE—A 20-in. "V" Gurley level as good as new and a New York rod outfit for $75, sent C. O. D. Address CHAS. H. SMITH, C. E., 15 North St., Middletown, N. Y. 27-3t

HASWELL'S MECHANICS' AND Engineers' Pocket Book, 57th Edition. Enlarged, with new and extensive Index. Cloth, 1007 pages. Price, $4. Forwarded by express. Chas. H. Haswell, P. O. Box 2961, New York.

CITY OF CAMBRIDGE.
TO BRIDGE BUILDERS.
PLATE GIRDER BRIDGE.

Sealed proposals will be received at the office of the Cambridge Water Board, City Hall, Cambridge, Mass., until 12 o'clock, m., of Tuesday, July 12, 1892, for the construction and erection of a wrought iron and steel plate girder highway bridge over the location and tracks of the Watertown Branch of the Fitchburg R. R., at Huron St., Cambridge.

The bridge to be Ninety-three (93) feet in length, and Fifty-eight (58) feet in width between the railings.

Plans and specifications can be seen and any information obtained at the office of the City Engineer, City Hall, Cambridge.

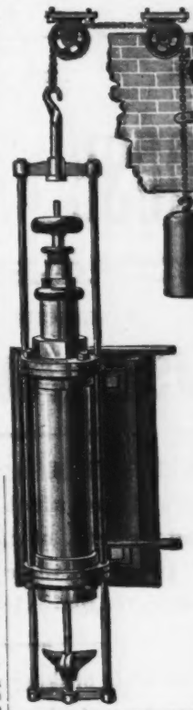
Each bid must be signed by the full business name and address of the bidder, and be accompanied by a certified check in the sum of Five Hundred ($500.00) Dollars, payable to the order of the City of Cambridge, which check will be returned unless forfeited as specified in the printed for of proposal. A satisfactory bond will be required of the successful bidder.

The right is reserved to reject any or all bids received.

Bids should be marked "Proposals for Huron St. Bridge," and addressed to the "Cambridge Water Board," Cambridge, Mass.

L. M. HASTINGS,
City Engineer.

Cambridge, June 30, 1892. 27-2t.



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from Maine to New Orleans, and have given the HIGHEST SATISFACTION. They will save you

STEAM, COAL AND MONEY.

They are controlled by steam direct from the boiler, and require neither street pressure nor extensive condensing surface to furnish water to operate them. Full particulars cheerfully furnished by the

CURTIS REGULATOR CO. 59 BEVERLEY STREET, BOSTON, MASS.

PROPOSALS FOR CONSTRUCTION OF WATER-WORKS.

Sealed proposals will be received at the office of the City Clerk, until noon, July 30, 1892, for furnishing the material and doing all the work, or any portion of either, for a system of water-works, in the city of Ponca, Dixon County, Neb. Plans and specifications may be obtained by addressing the Clerk of said city. Bids will be opened in the presence of bidders, at 4 o'clock, p. m., sharp, at the office of the City Clerk, on July 30, 1892. The right to reject any and all bids is hereby reserved.

Dated, Ponca, Neb., June 24, 1892.

F. M. DORSEY,
Mayor.

E. W. HUSE,
City Clerk. 27-3t

PROPOSALS OF DREDGING, UNITED States Engineer's Office, Mobile, Ala., June 18, 1892.—Sealed proposals in duplicate, for dredging in harbor of Biloxi Bay, Miss., will be received at this office until 12m., Monday, the 18th day of July, 1892, and opened immediately thereafter in the presence of bidders. Specifications, general instructions to bidders and blank proposal will be furnished on application to this office. The attention of bidders is invited to the Acts of Congress approved February 26, 1885, and February 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large.

A. N. DAMRELL,
26-3t Major of Engineers, U. S. A.

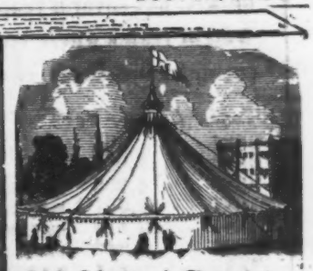
PROPOSALS FOR FURNISHING VITRIFIED PAVING BRICKS.
Office of the Commissioners, D. C.
Washington, D. C., June 25, 1892.

Sealed proposals will be received at this office until 12 o'clock m., on Saturday, July 16, 1892, for furnishing 2,000,000, more or less, vitrified paving bricks, to be used on various streets, avenues and alleys in the city of Washington.

Blank forms of proposal and specifications, together with all necessary information, can be obtained at this office, and only bids upon these forms will be considered.

J. W. DOUGLASS,
J. W. ROSS
W. T. ROSSELL,
Commissioners, D. C.
27-2t

TREASURY DEPARTMENT, Office Supervising Architect, Washington, D. C., June 24, 1892. Sealed proposals will be received at this office until 2 o'clock p. m. on the 19th day of July, 1892, and opened immediately thereafter, for all the labor and materials required for concrete and stone footings, etc., for the U. S. Post Office building at Washington, D. C., in accordance with the drawings and specification, copies of which may be had on application at this office, or the office of the Superintendent on the building site. Each bid must be accompanied by a certified check for a sum not less than 2% of the amount of the proposal. The right is reserved to reject any and all bids, and to waive any defect or informality in any bid or in the requested letters to accompany bids, if it be deemed in the interest of the Government to do so. Proposals received after the time stated will be returned to the bidders. Proposals must be enclosed Posal for Concrete and Stone Footings, in envelopes, sealed and marked "Proposals for Concrete and Stone Footings, Etc., for the U. S. Post Office Building at Washington, D. C.," and addressed to W. J. Edbrooke, Supervising Architect. 27-2t



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THE McAVLEY-PETERS TENT AND AWNING CO.
COLUMBUS, OHIO.

TREASURY DEPARTMENT, Office Supervising Architect, Washington, D. C., June 23, 1892. Sealed proposals will be received at this office until 2 o'clock p. m. on the 21st day of July, 1892, and opened immediately thereafter, for all the labor and materials required for the trench excavation, foundations, cut stone and brick work, of the basement and area walls, basement columns, first floor beams, girders and wood joists for the U. S. Court House and Post Office building at Tallahassee, Florida, in accordance with the drawings and the specification, copies of which may be had on application at this office or the office of the Superintendent at Tallahassee, Florida. Each bid must be accompanied by a certified check for a sum not less than 2% of the amount of the proposal. The right is reserved to reject any or all bids and to waive any defect or informality in any bid if it be deemed in the interest of the Government to do so. All proposals received after the time stated will be returned to the bidders. Proposals must be inclosed in envelopes, sealed and marked, "Proposal for Trench Excavation, Foundations, Cut Stone and Brick Work, Etc., for Basement and Area Walls of the U. S. Court House and Post Office Building at Tallahassee, Fla.," and addressed to W. J. Edbrooke, Supervising Architect. 27-2t

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WANTED—All consulting engineers, corporations, contractors, etc., to read Paret's advertisement about surveys. See page III.

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WANTED.—Bridge engineer, designer and draftsman whose present engagement expires July 1, would like to make an engagement with a railroad or bridge company. Am capable of taking entire charge of work, a graduate civil engineer of first-class experience, and can furnish the best of references, both as to character and ability. J. FRED. TEMPLE, San Francisco Bridge Co., Seattle, Wash. 14-tf

WANTED—Indices to Engineering News for volumes 14, 17, 22, 23, 24, 25. Will pay 10 cts. a copy if in good condition. Address this office.

WANTED—Engineering News for Jan. 3 and Dec. 5, 1891. Will give 10 cents each. Address this office.

WANTED.—Engineering News for Oct. 11, 1884. Will pay 30 cts. Must be in good condition. W. H. L., care Eng. News.

WANTED.—Assoc. Am. Soc. C. E. would like position as bridge draftsman. Experience as computer and author. Address L., care Engineering News. 22-6t

WANTED—Engineering News for 1892. Nos. 2, 3, 4, 6, 7 and 8, for which we will pay 15 cts. per copy, or we will send a copy of Cross' Field Book for any single number. In mailing, please roll long way of the paper and wrap full length; otherwise the leaves will tear, and we have no use for the torn copy. The number of each wanted is limited to 25 copies. Engineering News Pub. Co.

WANTED—"Engineering" (London), for 1890 and 1891, complete, with indexes and title pages. Will pay $5 per yearly volume, unbound. Address, MECHANICAL ENGINEER, care Eng. News. 24-6t

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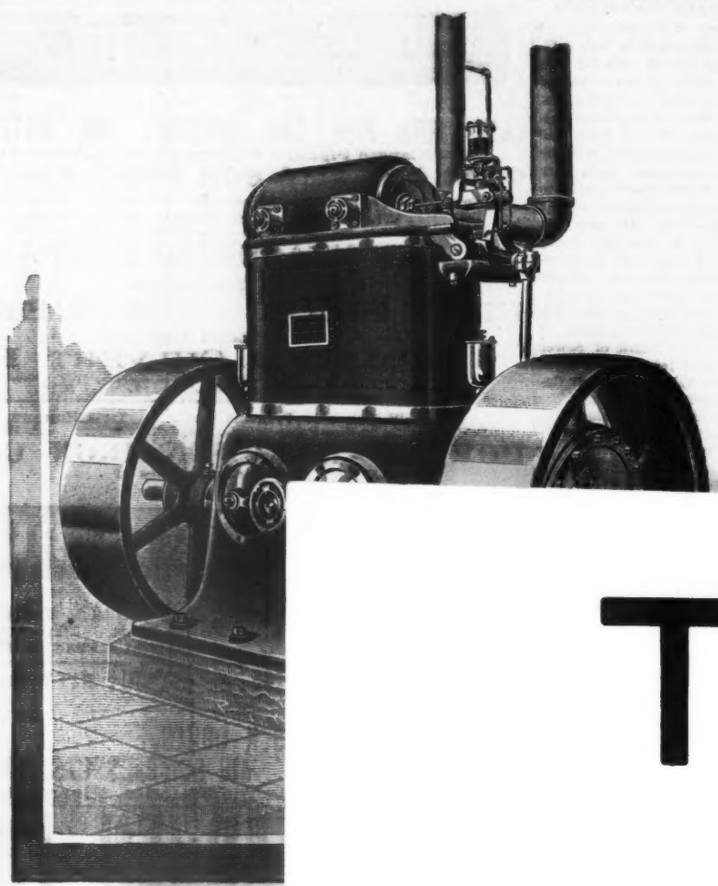

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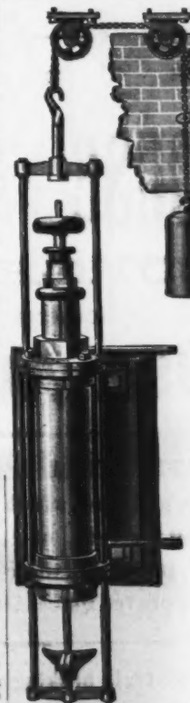

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from Maine to New Orleans, and have given the HIGHEST SATISFACTION. They will save you

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They are controlled by steam direct from the boiler, and require neither street pressure nor extensive condensing surface to furnish water to operate them. Full particulars cheerfully furnished by the

CURTIS REGULATOR CO. 59 BEVERLEY STREET, BOSTON, MASS.

PROPOSALS FOR CONSTRUCTION OF WATER-WORKS.

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Dated, Ponca, Neb., June 24, 1892.

F. M. DORSEY,
Mayor.

E. W. HUSE,
City Clerk. 27-3t

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THE McAVLEY-PETERS TENT AND AWNING CO. COLVMBVS, OHIO.

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A. N. DAMRELL,
26-3t Major of Engineers, U. S. A.

PROPOSALS FOR FURNISHING VITRIFIED PAVING BRICKS.

Office of the Commissioners, D. C.
Washington, D. C., June 25, 1892.

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Blank forms of proposal and specifications, together with all necessary information, can be obtained at this office, and only bids upon these forms will be considered.

J. W. DOUGLASS,
J. W. ROSS
W. T. ROSSELL.
27-2t Commissioners, D. C.

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TREASURY DEPARTMENT, Office Supervising Architect, Washington, D. C., June 23, 1892. Sealed proposals will be received at this office until 2 o'clock p. m. on the 21st day of July, 1892, and opened immediately thereafter, for all the labor and materials required for the trench excavation, foundations, cut stone and brick work, of the basement and area walls, basement columns, first floor beams, girders and wood joists for the U. S. Court House and Post Office building at Tallahassee, Florida, in accordance with the drawings and the specification, copies of which may be had on application at this office or the office of the Superintendent at Tallahassee, Florida. Each bid must be accompanied by a certified check for a sum not less than 2% of the amount of the proposal. The right is reserved to reject any or all bids and to waive any defect or informality in any bid if it be deemed in the interest of the Government to do so. All proposals received after the time stated will be returned to the bidders. Proposals must be inclosed in envelopes, sealed and marked, "Proposal for Trench Excavation, Foundations, Cut Stone and Brick Work, Etc., for Basement and Area Walls of the U. S. Court House and Post Office Building at Tallahassee, Fla.," and addressed to W. J. Edbrooke, Supervising Architect. 27-2t

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CITY OF CAMBRIDGE.
TO BRIDGE BUILDERS.
PLATE GIRDER BRIDGE.

Sealed proposals will be received at the office of the Cambridge Water Board, City Hall, Cambridge, Mass., until 12 o'clock, m., of Tuesday, July 12, 1892, for the construction and erection of a wrought iron and steel plate girder highway bridge over the location and tracks of the Watertown Branch of the Fitchburg R. R., at Huron St., Cambridge.

The bridge to be Ninety-three (93) feet in length, and Fifty-eight (58) feet in width between the railings.

Plans and specifications can be seen and any information obtained at the office of the City Engineer, City Hall, Cambridge.

Each bid must be signed by the full business name and address of the bidder, and be accompanied by a certified check in the sum of Five Hundred ($500.00) Dollars, payable to the order of the City of Cambridge, which check will be returned unless forfeited as specified in the printed for of proposal. A satisfactory bond will be required of the successful bidder.

The right is reserved to reject any or all bids received.

Bids should be marked "Proposals for Huron St. Bridge," and addressed to the "Cambridge Water Board," Cambridge, Mass.

L. M. HASTINGS,
City Engineer.

Cambridge, June 30, 1892. 27-2t.

GEO. WESTINGHOUSE, JR., President. T. W. WELSH, Supt. JOHN CALDWELL, Treasurer. W. W. CARD, Secretary. H. H. WESTINGHOUSE, General Manager.

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1882	1,085	1,190
1883	4,966	6,156
1884	15,051	21,207
1885	10,410	31,617
1886	8,946	40,563
1887	9,281	49,844
1888	27,696	77,540
1889	26,065	103,605
1890	50,502	154,107
1891	39,061	193,168

193,168 freight cars fitted with the Westinghouse Automatic Brake, which is nearly 20 per cent. of the Entire Freight Car Equipment of this country.

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NEW YORK OFFICE: 160 Broadway JOHN B. GRAY, Agent.

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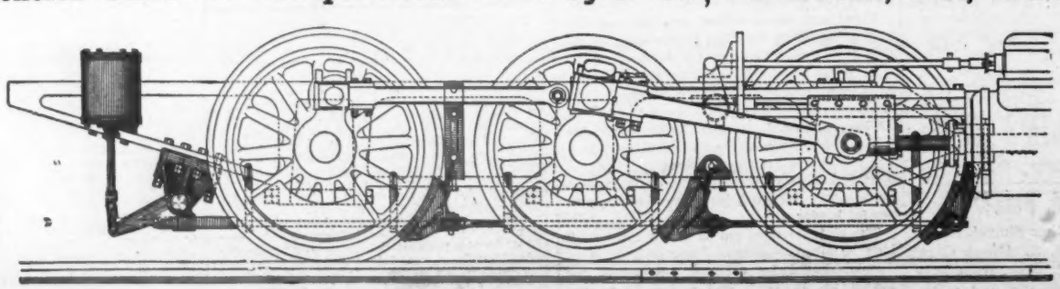

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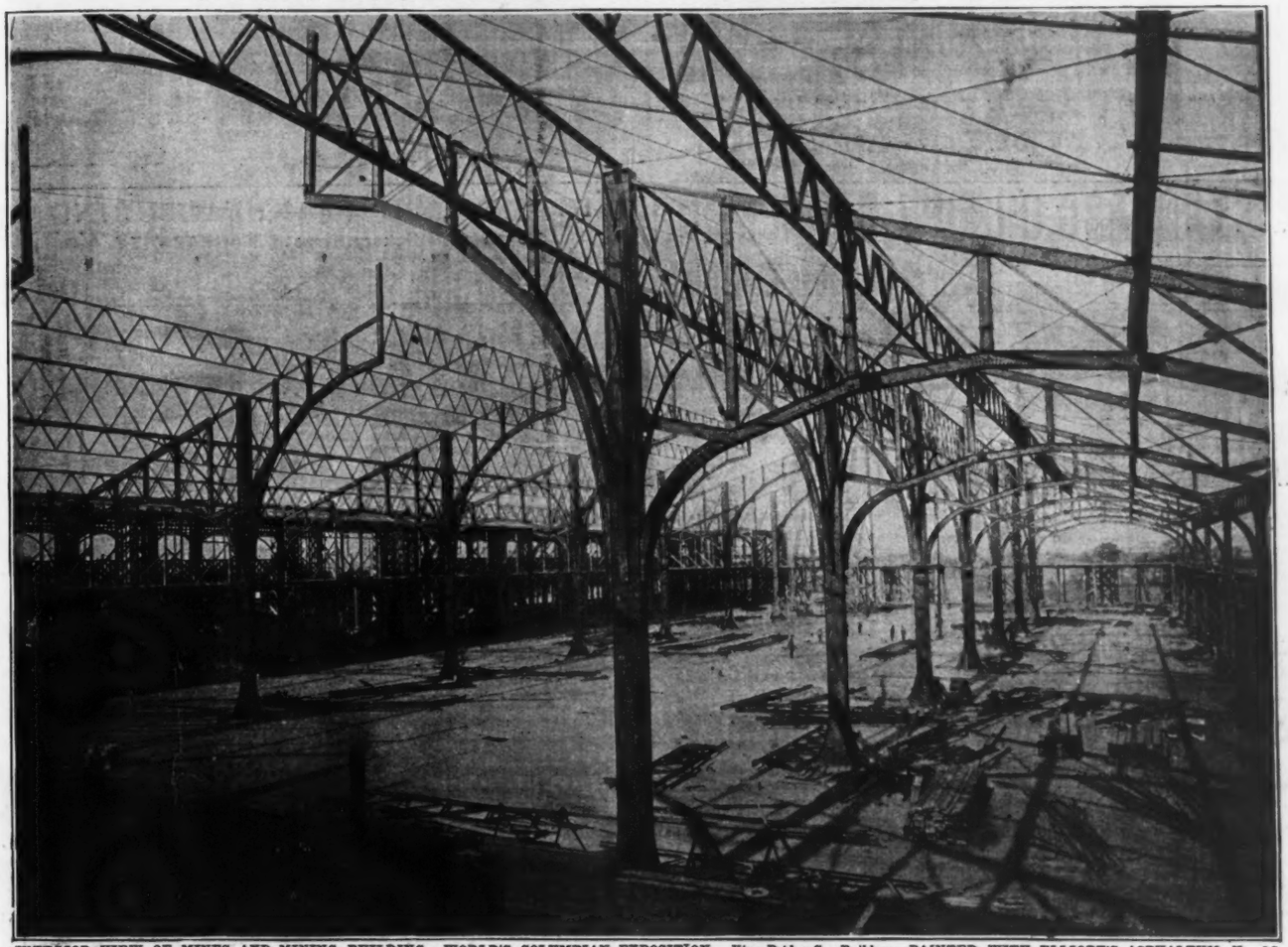

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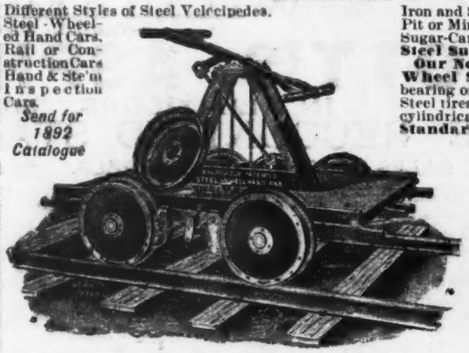

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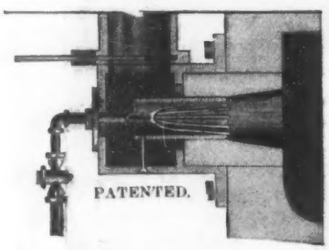

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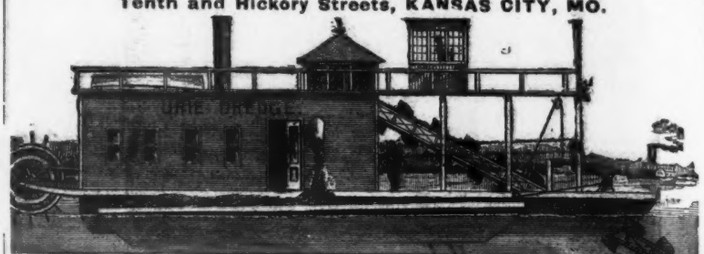

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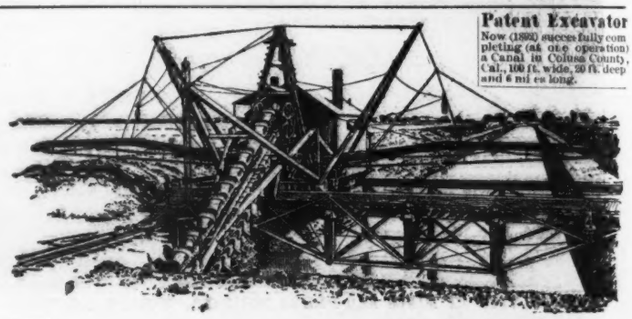

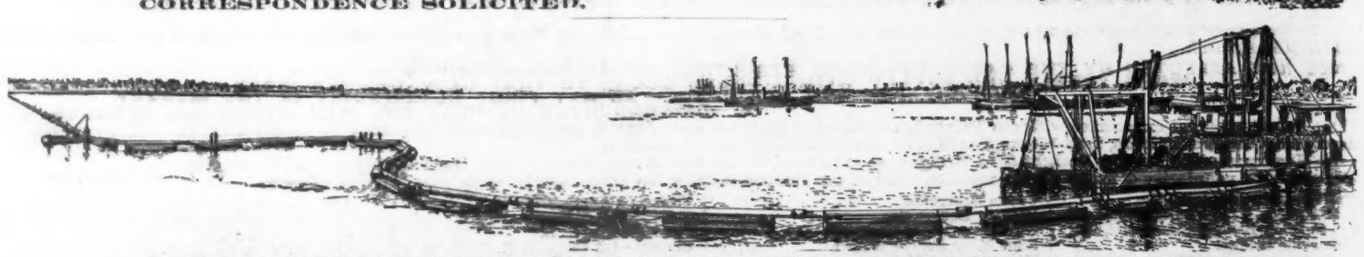

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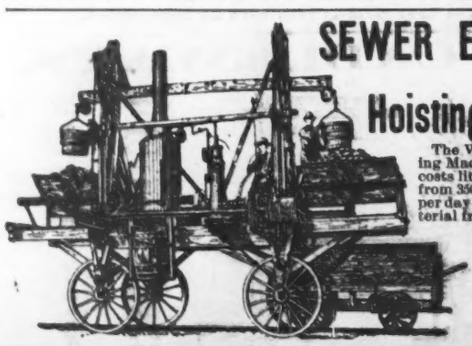

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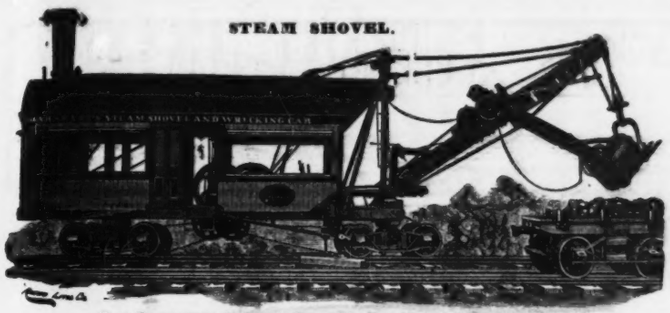

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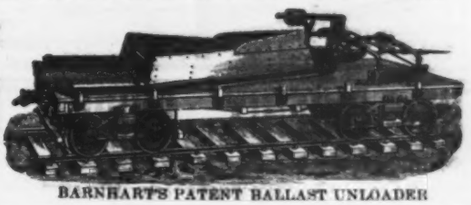

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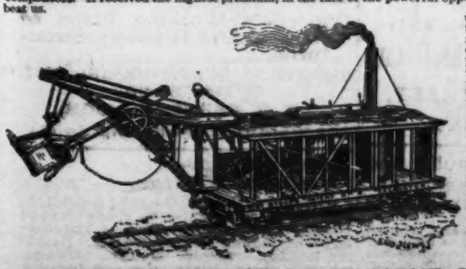

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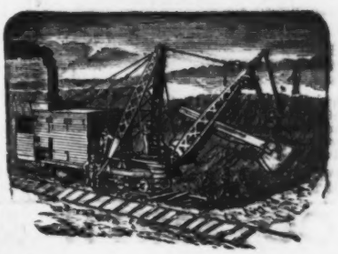

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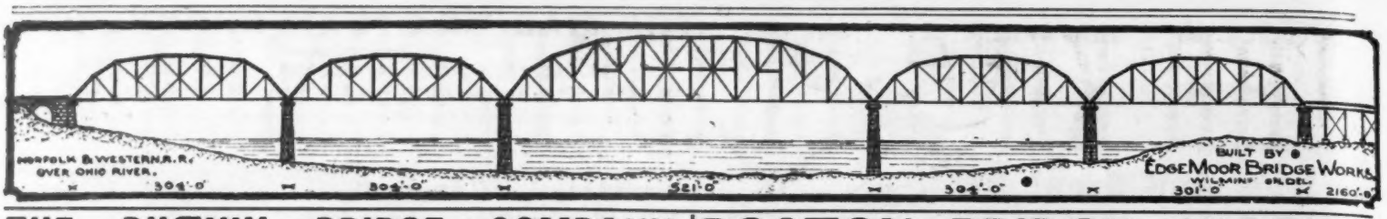

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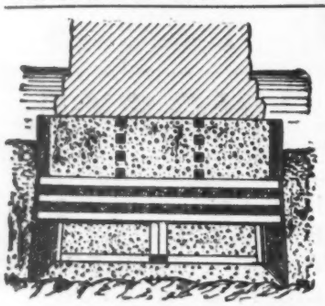

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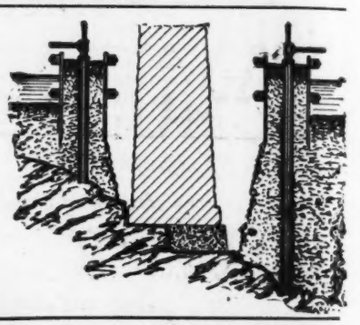

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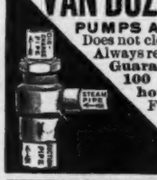

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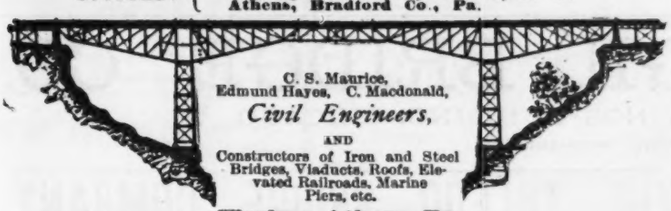

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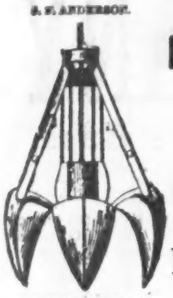

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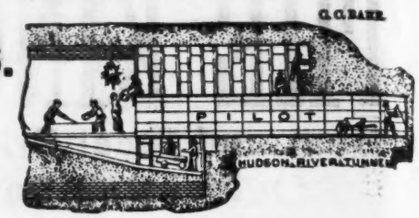

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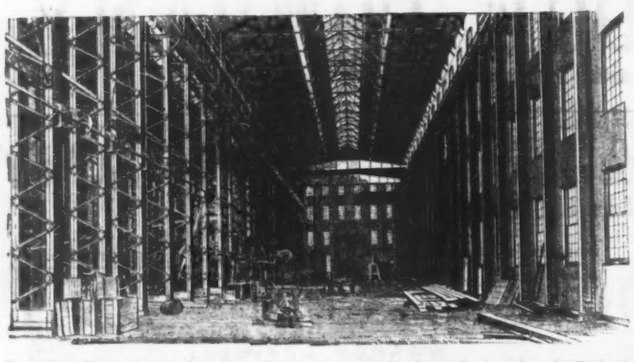

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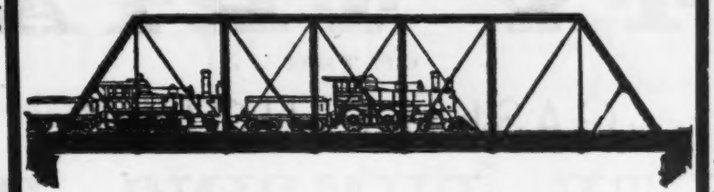

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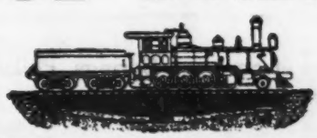

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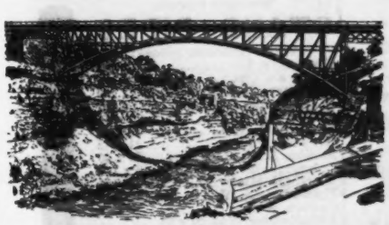

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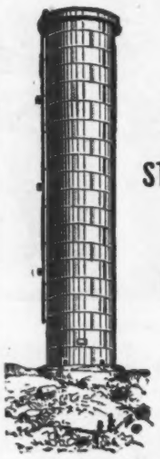

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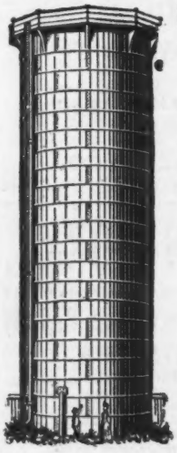

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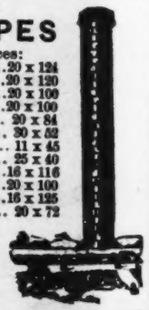

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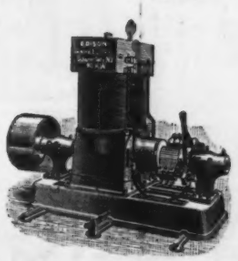

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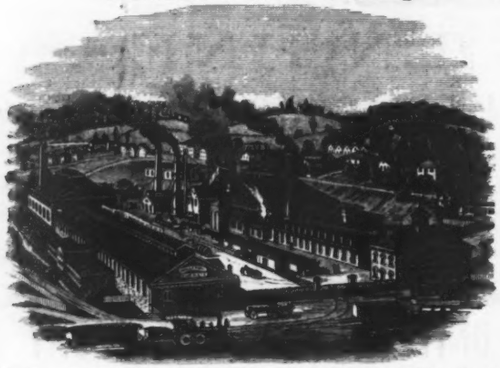

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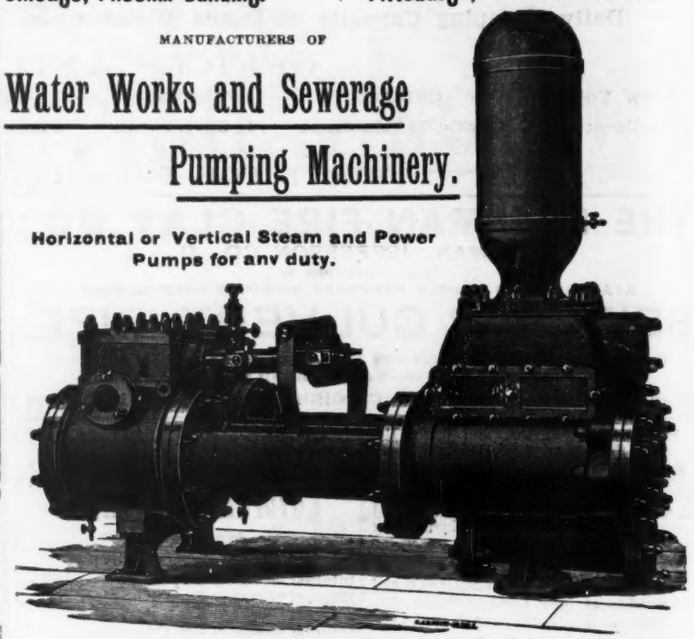

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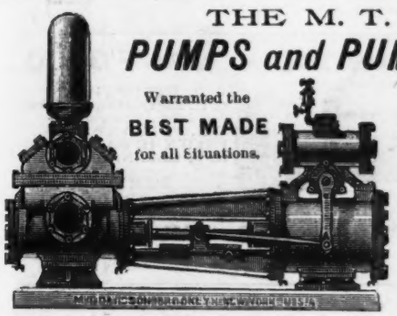

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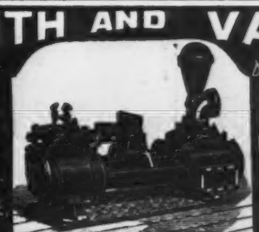

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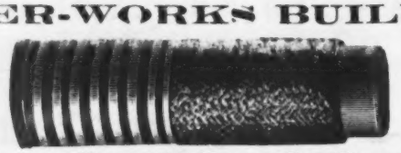

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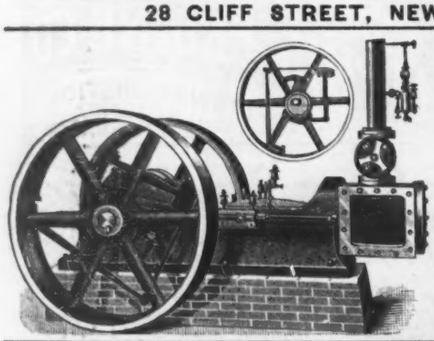

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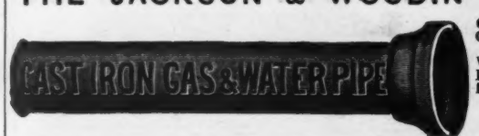

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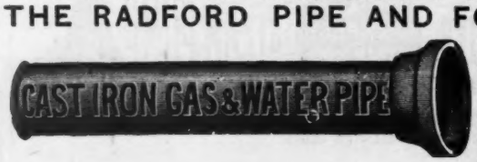

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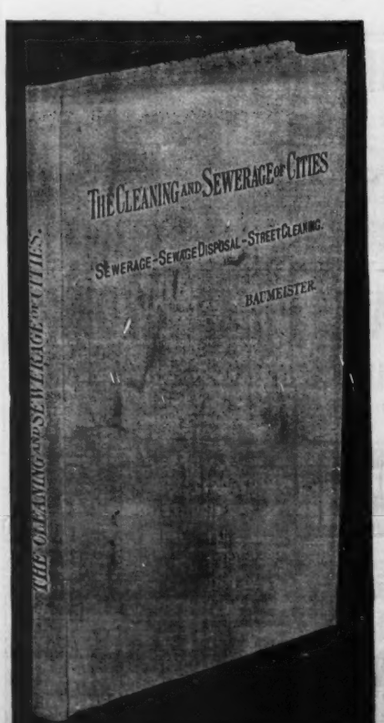

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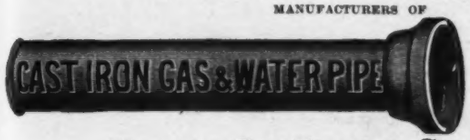

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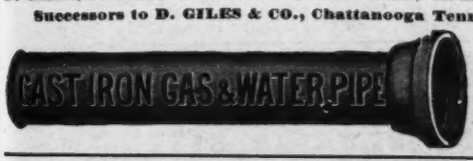

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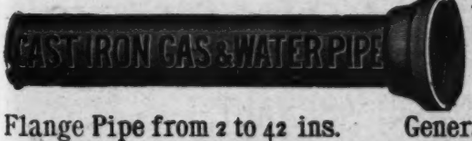

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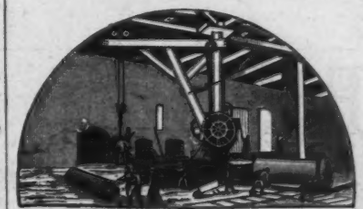

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